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U. S. DEPARTMENT OF AGRICULTURE

COTTON TESTING *Service*

TESTS AVAILABLE

EQUIPMENT AND TECHNIQUES

BASIS FOR INTERPRETING REPORTS

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE • Cotton Division
FEBRUARY 1955
WASHINGTON, D. C.

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This publication was planned and prepared under the direction of John W. Wright, Chief, Standards and Testing Branch, Cotton Division, Agricultural Marketing Service. It is a revision of a similar publication issued in July 1952. This revision reflects the changes brought about by the latest issue of Regulations and Fees for Cotton Testing Service, Effective August 1, 1954.

COTTON TESTING SERVICE: TESTS AVAILABLE, EQUIPMENT AND TECHNIQUES, AND BASIS FOR INTERPRETING RESULTS

INTRODUCTION

This bulletin describes various cotton fiber and manufacturing tests available on a fee basis under the Cotton Testing Service Act (7 U.S.C. 473d), the methods employed in making the tests, and the significance of the test results. A complete list of the tests available and the schedule of fees are shown in a companion publication entitled "Regulations and Fees for Cotton Testing Service," effective August 1, 1954.

Laboratories for making tests are located at:

Standards and Testing Branch, Cotton Division, AMS, USDA, Washington 25, D. C.
Clemson Cotton Laboratory, Box 67, Clemson, S. C.
Stoneville Cotton Laboratory, Box 218, Stoneville, Miss.
College Station Cotton Laboratory, Box 297, College Station, Tex.
Mesilla Park Cotton Laboratory, Box 308, Mesilla Park, N. Mex.

The special equipment required and the high degree of skill necessary for obtaining accurate test results have made it advisable to provide a certain degree of specialization in the making of such tests at the various laboratories. Table 1 shows the kinds of service tests that are being performed at each of the testing laboratories.

Scheduling of tests and supervision and coordination of the work of all five laboratories are carried out through the Standards and Testing Branch of the Cotton Division. For the most expeditious service, inquiries concerning tests should be addressed to that office. Persons requesting service tests will be notified as to which laboratory their samples should be sent. However, requests may be made directly to the laboratory nearest the applicant. Samples for tests to be performed at other laboratories will be prepared and forwarded by the laboratory receiving the samples. All seed cotton samples from pink boll worm areas that require ginning prior to testing should be forwarded to the Mesilla Park Laboratory, Mesilla Park, N. Mex.

All inquiries concerning policies or the broad interpretation of test results should be addressed to the Washington office. Questions concerning specific test results may be addressed to the laboratory which prepared the report.

Table 1.--Kinds of service tests performed at each of the five testing laboratories operated by the Cotton Division

Kind of test	Fiber and spinning: Clemson, S. C.	Fiber and spinning: College Station, Tex.	Fiber: Stoneville, Miss.	Fiber: Mesilla Park, N. Mex.	Fiber: Washington, D. C.
Seed cotton:					
Ginning of test samples	No	No	Yes	Yes	No
Foreign material content	No	No	Yes	Yes	No
Moisture content	No	No	Yes	Yes	No
Fiber tests:					
Length (array)	Yes	Yes	Yes	No	Yes
Length (Fibrograph)	Yes	Yes	Yes	Yes	Yes
Strength	Yes	Yes	Yes	Yes	Yes
Fineness and maturity (Causticaire)	No	No	No	No	Yes
Fineness and maturity (array)	Yes	Yes	No	No	Yes
Fineness (Micronaire)	Yes	Yes	Yes	Yes	Yes
Raw stock nep content	No	No	Yes	Yes	Yes
Furnishing check test samples	No	No	No	No	Yes
Blending test samples	Yes	Yes	Yes	Yes	Yes
Moisture content	Yes	Yes	Yes	Yes	Yes
Foreign material content	Yes	Yes	Yes	Yes	Yes
Classification	Yes	Yes	Yes	Yes	Yes
Processing tests:					
Spinning carded yarns 1/	Yes	Yes	No	No	No
Spinning combed yarns 1/	Yes	No	No	No	No
Slashing and weaving 2/	Yes	No	No	No	No
Other tests:					
Furnishing identified samples	Yes	Yes	Yes	Yes	Yes
Furnishing copies of results	Yes	Yes	Yes	Yes	Yes

1/ Includes all extra items performed in connection with the spinning tests and other items which are a part of the spinning tests.

2/ Includes spinning of the yarn and testing of the fabric in connection with spinning tests.

SELECTION AND PREPARATION OF SAMPLES

Results of the fiber and processing tests can be no more representative of cottons than are the samples themselves; therefore, the proper size, selection, and preparation of samples are extremely important. The following suggestions relative to the selection and preparation of samples are designed to aid applicants for testing services in obtaining the most reliable results possible:

Size.--1 ounce or more for fiber tests.
6 pounds or more for each carded yarn spinning test.
8 pounds or more for each combed yarn spinning test.
10 pounds or more for carded and combed yarn spinning tests.

(When a spinning test on a composite sample representing a mill mix is requested, approximately equal portions from each bale totaling 10 pounds of cotton should be submitted for each mix. When a mill mix contains 40 or more bales, however, at least 4 ounces should be submitted from each bale.)

Selection.--In view of the high degree of variability found for all measurable properties of cotton within a bale, or even within a small sample, it is very important that care be exercised in selecting the fibers that are actually to be tested. Otherwise, the test specimens may not be truly representative, and an erroneous impression may be formed, of the cotton being tested. A more detailed discussion of the problem of variability of cotton appears on page 48.

When breeders submit samples of seed cotton to be ginned, the samples should be representative of the breeding block. In instances were the breeder does his own ginning, the seed cotton should be mixed thoroughly before ginning, and preferably the sample should be drawn from approximately the midpoint in the ginning process. Saw-ginned lint for upland cottons is preferred, as it is not possible to obtain an accurate grade designation for such cotton on roller-ginned samples. Except for comparative purposes, it is inadvisable to submit samples that have been weather damaged, as the lint may no longer be representative of the normal qualities of the seed stock being studied.

Where spinning tests are to be made from commercial bales and other relatively large supplies of lint, the samples should be composed of equal quantities of cotton taken from a number of places in the bale. In cases where a spinning test sample is to represent a mill "mix," equal quantities of cotton should be selected from each bale in the mix, unless otherwise desired by the applicant.

SELECTION OF TESTS

In making requests for tests, it should be borne in mind that each test is designed to give specific information regarding some phase or phases of cotton quality. Only those tests that will furnish helpful data in explaining the cotton quality problems being studied should be requested. A well-planned test will generally yield more useful data on a specific problem, and may cost less, than a carelessly planned tests. Selection of the tests desired is, of course, a matter for the applicant to decide. Helpful suggestions regarding the most suitable tests for solving specific problems may be obtained, however, by writing to the Washington office or to one of the field laboratories. Requests for such suggestions should outline briefly the purpose for which the service tests are needed and should give any available information regarding the varieties of cotton, place of growth or other pertinent information. By reviewing Department of Agriculture publications that show spinning and fiber properties of various varieties and growths of cotton, the applicant may obtain suggestions that will be helpful in determining the kind of tests best suited for his purpose.

DESCRIPTION OF TESTS AND INTERPRETATION OF TEST RESULTS

Seed Cotton Tests

Ginning of test samples (1). 1/--This item includes the ginning of seed cotton to produce sufficient lint for the fiber and spinning tests. From 5 to 10 pounds of lint are required for these tests. The ginning is performed on a saw gin equipped with an extractor cleaner feeder. When only fiber tests are requested, two pounds of seed cotton may be ginned on a smaller gin without an extractor cleaner feeder. The lint and seed are both weighed and reported along with the percentage of lint turn-out. When spinning tests are to be made on the lint, the laboratory selects, packs, marks, and ships the test samples to the designated spinning laboratory. If the applicant requests it, the cottonseed will be returned at his expense.

Fractionation of foreign material (4).--This item provides a means for determining foreign material content in samples of seed cotton. Care should be exercised to submit a representative sample of seed cotton weighing from 1 to 2 pounds. The sample is given a preliminary preparation by hand to the extent that sticks and hulls are removed before placing the sample in a device developed by the laboratories of the Cotton Division for making this test (fig. 1). Compressed air is used to agitate the sample in a semi-cylindrical chamber, and trash is screened from the discharged air. Reports of the test show the average percentage of foreign material in the seed cotton based on a 300-gram sample.

Determination of moisture content (10b).--This item consists of the weighing and drying of samples of unginned seed cotton. The samples are dried in drying ovens (fig. 2), and the moisture content is calculated by using the following formula:

$$\text{Moisture content percentage} = \frac{\text{original weight} - \text{dry weight} \times 100}{\text{original weight}}$$

The moisture content percentage is reported for each sample.

1/ Numbers in parentheses refer to item numbers in the Regulations and Fees for Cotton Testing Service, effective August 1, 1954.

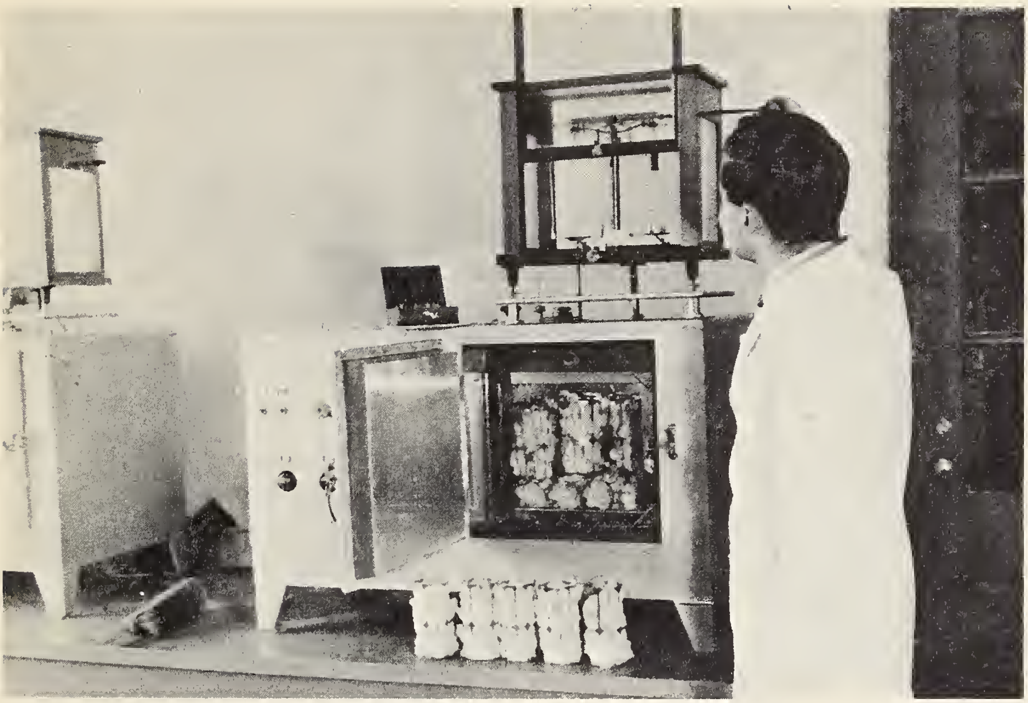

Figure 1.--Technician performing fractionation tests for determining foreign material content in samples of seed cotton.

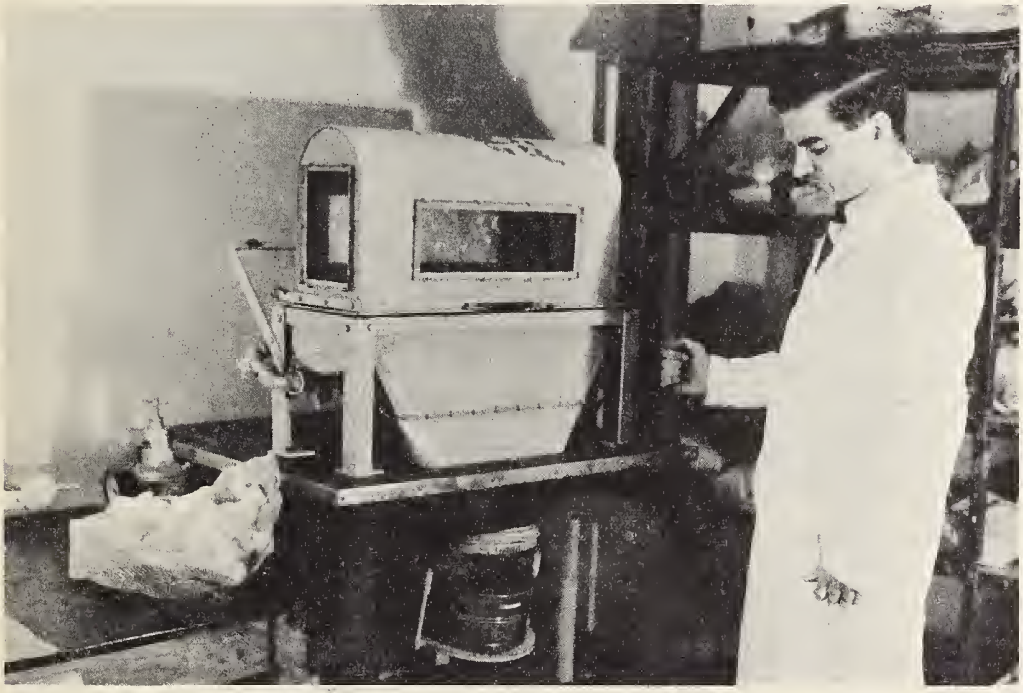

Figure 2.--Technician performing tests for determining moisture content in seed cotton and cotton lint.

Fiber Tests and Their Evaluation

A general view of fiber laboratory facilities is shown in figure 3. Fiber tests are conducted under standard atmospheric conditions of 70°F. ± 2° and 65 percent relative humidity ± 2%, after the samples have been conditioned for 4 hours or more.

Fiber length array (2).--This item consists of tests made with the Suter-Webb fiber sorter (fig. 4). Briefly, three representative 75-mg. samples of cotton are parallelized through a series of combs. The fibers are separated and arrayed on velvet-covered boards according to length, as illustrated in figure 5. The different length groups, at 1/8-inch intervals, are measured and weighed. Averages of the results for three arrays are calculated and reported for the upper quartile length, mean length, and coefficient of length variation.

The upper quartile length is the length which is exceeded by 25 percent of the fibers, by weight, in the sample. It is usually closely related to, but slightly longer than, the classer's staple length designation. Its relationship to that value may vary, however, because this method does not select and measure "a typical portion of fibers" as required in designating staple length, or does it adjust for character defects for which the classer may reduce the staple length designation.

The mean length is the average length of all fibers in the sample, as determined from the weight-length data.

The coefficient of length variation is a measure of the variability of fiber length in the sample and represents the standard deviation of the weight-length frequencies expressed as a percentage of the mean length. The smaller the value the more uniform are the fiber lengths. Excessive variation in fiber length tends to increase manufacturing waste, makes processing more difficult, and tends to lower the quality of the product. It is, therefore, desirable for a cotton to have a low coefficient of variation. Comparisons between samples may be made according to the following descriptive designations:

Coefficient of fiber length variation

Below 27...........	Low variability
27 to 34...........	Average variability
35 and above.......	High variability

For those persons who desire more complete data for the purpose of plotting fiber length array curves or for more detailed study of length distribution, item (2.1) was designed. In addition to the three values reported in item (2), the item (2.1) includes the percentage of fibers by weight in each 1/8-inch length group.

Item (2.2) was designed to provide detailed data required in connection with the United States Pharmacopoeia Standards for purified or absorbent cotton. This item involves the preparation of fiber length

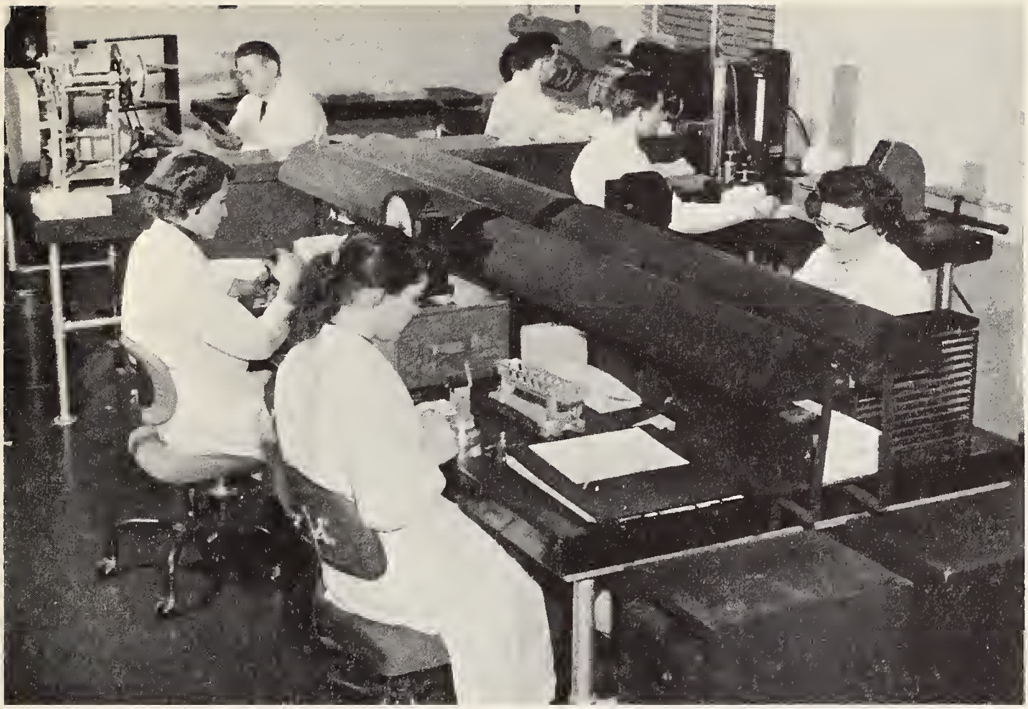

Figure 3.--General view of fiber laboratory.

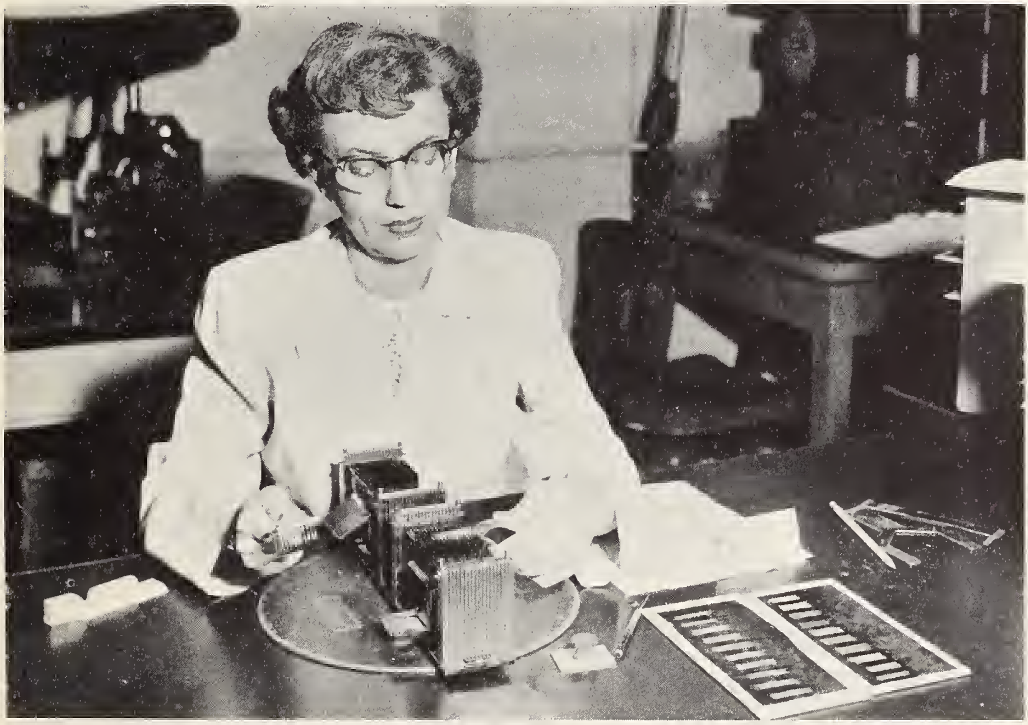

Figure 4.--Technician performing fiber length tests on cotton lint using the Suter-Webb fiber sorter.

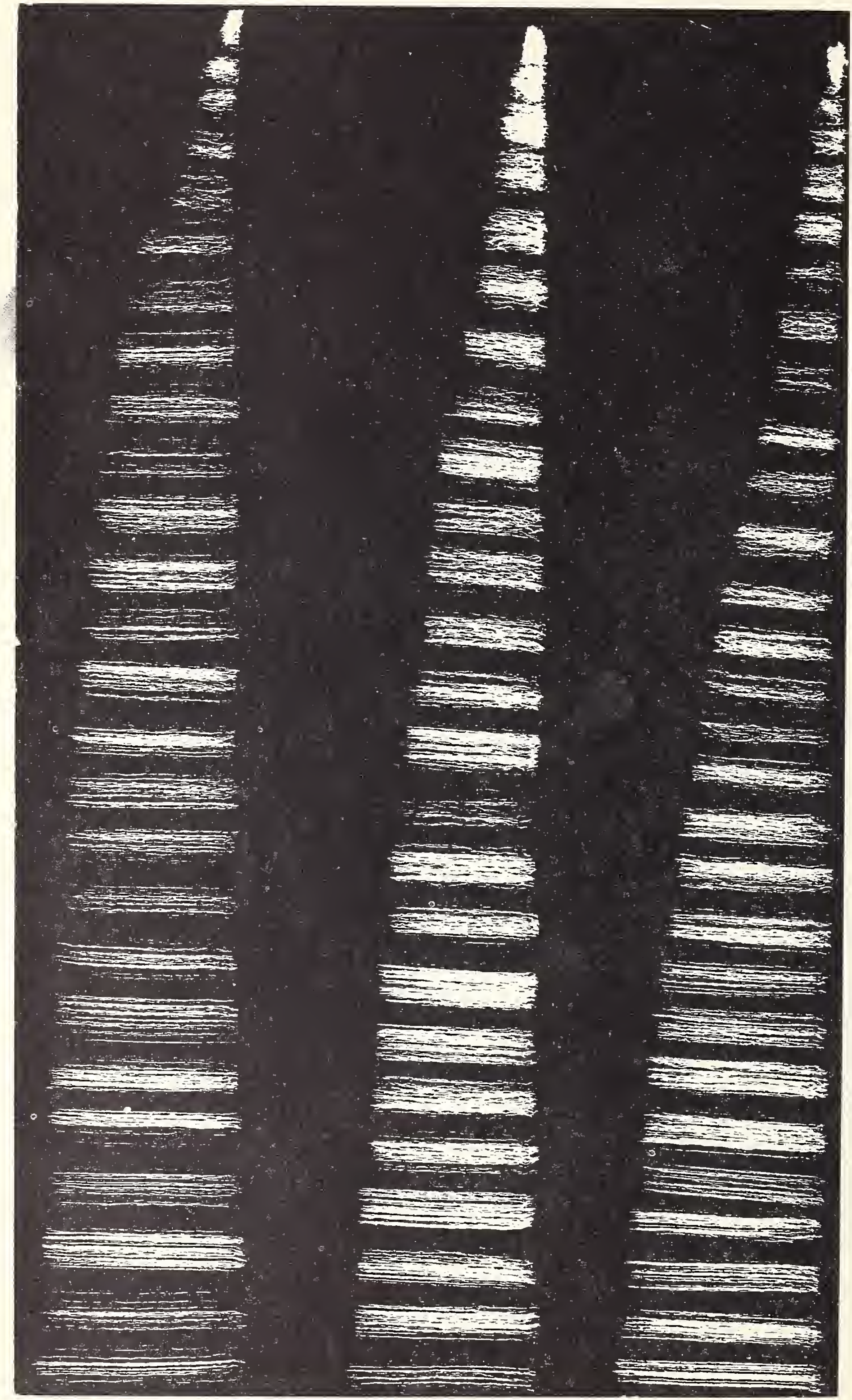

Figure 5.--Fiber length arrays (about actual size) of different cottons illustrating: (Top) a cotton with relatively high length uniformity; (center) average fiber uniformity; (bottom) a cotton of irregular fiber length.

arrays on the Suter-Webb Sorter, and the determination of the percentages of fiber which are (a) 1/2-inch long and longer; and (b) shorter than 1/4-inch in length, in addition to the values reported for item (2).

All averages reported for fiber sorter results are based on three arrays which have been shown by statistical studies to be necessary for reliable results. A special study indicates that the accuracy of reproducibility of the results for the array test is as follows:

	Standard error for cotton	
Item	Shorter than 1-1/8" staple	1-1/8" and longer
Upper quartile length (inches)........	± 0.007	± 0.012
Mean length (inches)..................	± 0.007	± 0.012
Coefficient of length variability (percent)..........................	± 0.7	± 1.2

Fiber length (Fibrograph) (3 and 3.1).--These items provide measures of fiber length as determined by the Fibrograph which is a photoelectric device for measuring the length and length distribution of the fibers in a sample of cotton (fig. 6).

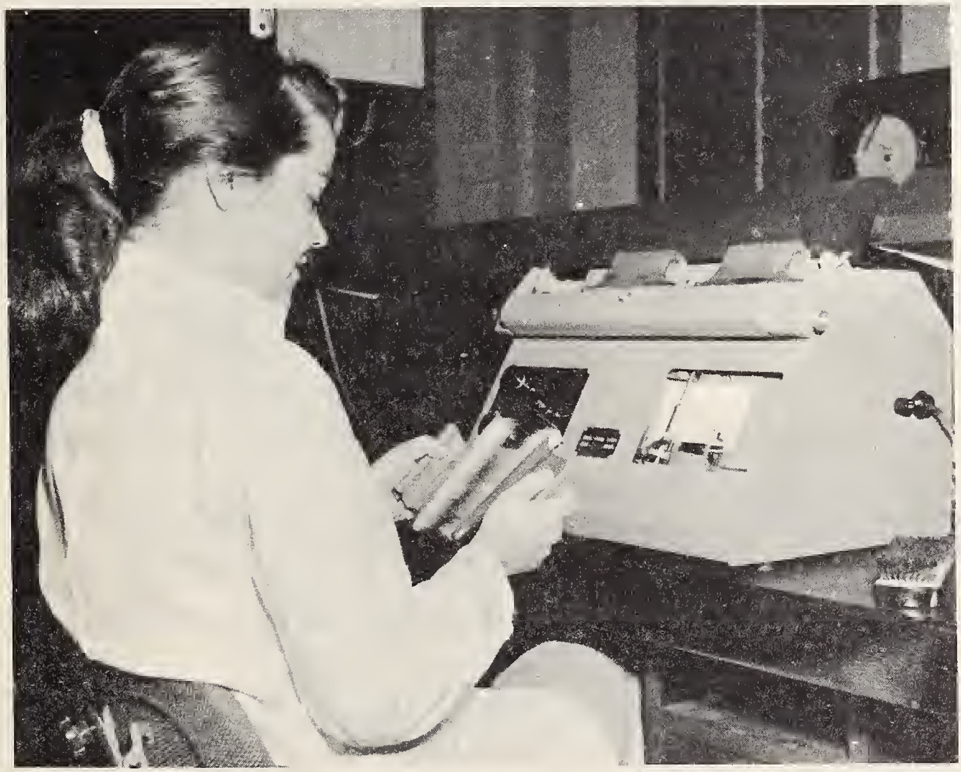

Figure 6.--Technician performing fiber length tests on cotton lint using the Fibrograph instrument.

The "upper half mean length," as determined by this instrument, provides a measure of the average length of all fibers longer than the mean length, expressed in terms of decimal fractions of an inch. Although the "upper half mean length" is closely related to the classer's designation of staple length, it may vary from that value because this method does not select and measure "a typical portion of fibers" as required in designating staple length or does it adjust for character defects for which the classer may assign a shorter staple length designation. "Mean length" is the average length of the fibers in the sample, excluding those approximately 1/4-inch and shorter. The "uniformity ratio" expresses the relation between the mean length of the fibers and the upper half mean length, and provides a relative measure of the length uniformity of the fibers. The larger the value reported, the more uniform the fiber length. For practical purposes, comparisons between samples may be made according to the following descriptive designations:

Uniformity ratio	
Above 80.........	Uniform in fiber length
75 to 80.........	Average uniformity
74 and below.....	Irregular in fiber length

The uniformity ratio as determined from Fibrograph data is not mathematically comparable with coefficient of variation based on the sorter array. The latter is based on the weight of all fibers in the sample, whereas the Fibrograph data are based on the number of fibers and disregards fibers approximately 1/4-inch and shorter.

Average Fibrograph values reported for individual samples, item (3), are based on four determinations which have been shown by statistical studies to be necessary for reliable results. In the case of item (3.1), however, the results for the two determinations on each of three or more subsamples are averaged to obtain a representative value for the entire group of subsamples. A special study indicates that the accuracy of the reproducibility of the results for the Fibrograph test as based on four determinations is as follows:

Item	Standard error for cottons shorter than 1-1/8" staple
Upper half mean length (inches)........	± 0.008
Mean length (inches)....................	± 0.015
Length uniformity (index)..............	± 1.1

Fiber strength (5 and 5.1).--Fiber tensile strength is determined by using a flat bundle Pressley strength tester (fig. 7). In making the test, cotton is hand-combed and the fibers are parallelized in the form of a flat ribbon about 3/16-to 1/4-inch wide and then placed in a set of breaking clamps. The fibers are cut to a definite length, broken in the Pressley tester, and then weighed. The strength of the specimen, as indicated on the beam of the machine is read to the nearest tenth of a pound and the weight of the specimen is read to the nearest hundreth of a milligram as a basis for the calculation of the fiber strength results.

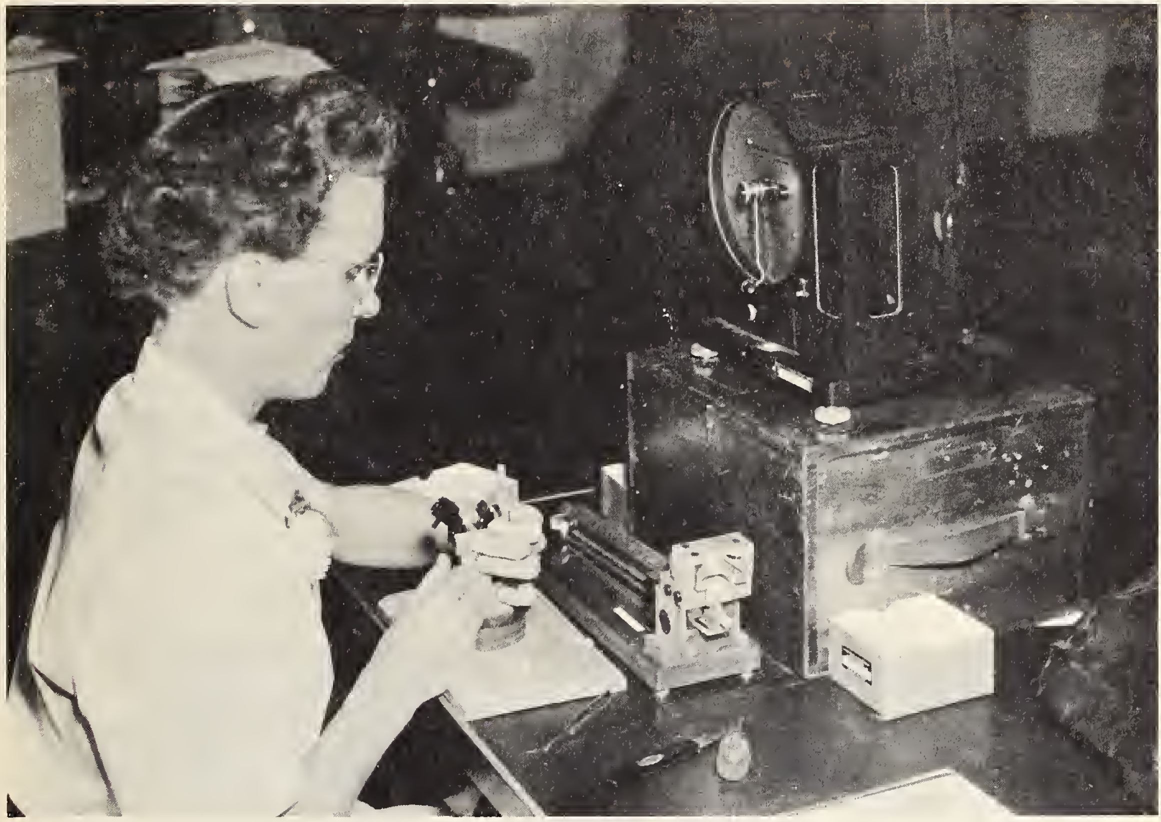

Figure 7.--Technician performing fiber strength tests on cotton lint using the Pressley instrument

Fiber strength is an important factor in determining yarn strength. Cottons with good fiber strength usually give less trouble in manufacturing processes than do weak-fibered cottons.

Previously, fiber strength tests were performed without any space between the jaws (0 gauge), but now are performed with a 1/8-inch space between the jaws (1/8-inch gauge) unless 0 gauge tests are specifically requested. Results of a special study indicated that fiber strength obtained at 1/8-inch gauge is more highly correlated with yarn strength than fiber strength obtained at 0 gauge.

In calculating the test results, the Pressley ratio (1/8-inch gauge) is obtained by dividing the weight of the specimen in milligrams into the strength of the specimen in pounds and then adjusting the quotient to a standard level from results of tests on check cottons. This ratio for an individual cotton, when divided by an average ratio of 3.19 and multiplied by 100, is converted to a fiber strength index which indicates higher than average strength by values larger than 100 and lower than average strength by values smaller than 100.

The following adjective ratings will assist in the interpretation of the test data reported and serve to facilitate comparisons between cottons:

Fiber strength index

Above 115	Very strong
106 to 115	Strong
96 to 105	Average
86 to 95	Fair
85 or less	Weak

The average strength index reported for individual samples, item (5), is based on six breaks which have been shown by statistical studies to be necessary for reliable results. In the case of item (5.1), however, the results for the two breaks on each of three or more subsamples are averaged to obtain a representative value for the entire group of replicate subsamples. A special study indicated that the accuracy of the reproducibility of the results for the Pressley strength test as based on six breaks, is as follows:

	Standard error
Fiber strength index (Pressley 1/8-inch gauge)	± 0.9

Pressley strength tests were made at both 0 and 1/8-inch gauge for 323 samples of commercial cottons from the 1954 crop which were used as a basis for the fiber strength index. The Pressley strength (0 gauge) for these cottons averaged 84 thousand pounds per square inch and the Pressley ratio (1/8-inch gauge) averaged 3.19. The fiber strength index as reported may, therefore, be converted to other methods of expressing fiber strength by applying the following formulas:

$$(1)\quad S_2 = \frac{S_1 \times 3.19}{100}$$

$$(2)\quad S_3 = S_2 \times 0.68$$

$$(3)\quad S_4 = \frac{S_1 \times 84}{100}$$

where: S_1 = Fiber strength index (Pressley 1/8-inch gauge)
S_2 = Pressley ratio (1/8-inch gauge)
S_3 = Grams/grex (Pressley 1/8-inch gauge)
S_4 = Estimated 1,000 lbs. per square inch (0 gauge)

In applying formula (3) above, in order to convert the results of 1/8-inch gauge tests to the general level of the results of 0 gauge, it should be understood that the estimated strength and the actual values may differ greatly for individual cottons. However, the averages for a large number of cottons should agree very closely.

Fiber fineness and maturity (Causticaire) (6).--This is a newly developed item [2] in which the Micronaire instrument (fig. 8) is used to measure the resistance to the passage of air through a 50-grain sample of cotton compressed to a given volume. By means of a special Causticaire scale for the Micronaire instrument (fig. 9), readings are made on samples of both untreated cotton and cotton treated with sodium hydroxide (40 Tw.) The caustic treatment swells the fibers causing them to become cylindrical in shape. Thus, fineness values for all botanical types of cotton can be read from a single Micronaire scale. Maturity index reflects the degree of cell-wall development throughout the entire length of the fibers. Statistical analyses of the results of empirical tests have shown the maturity values obtained by the Causticaire method have greater significance from the standpoint of relationship to spinning performance than maturity values obtained by other available methods. Causticaire fineness and maturity values are calculated by applying the following formulas:

$$\text{Causticaire maturity (index)} = \frac{\text{Average Causticaire reading (untreated)} \times 100}{\text{Average Causticaire reading (treated)}}$$

$$\text{Causticaire fineness (micrograms per inch)} = +1.185 + 0.00075\,(T^2) - 0.020\,(MI)$$

where, T = average of readings on treated specimen
MI = maturity index

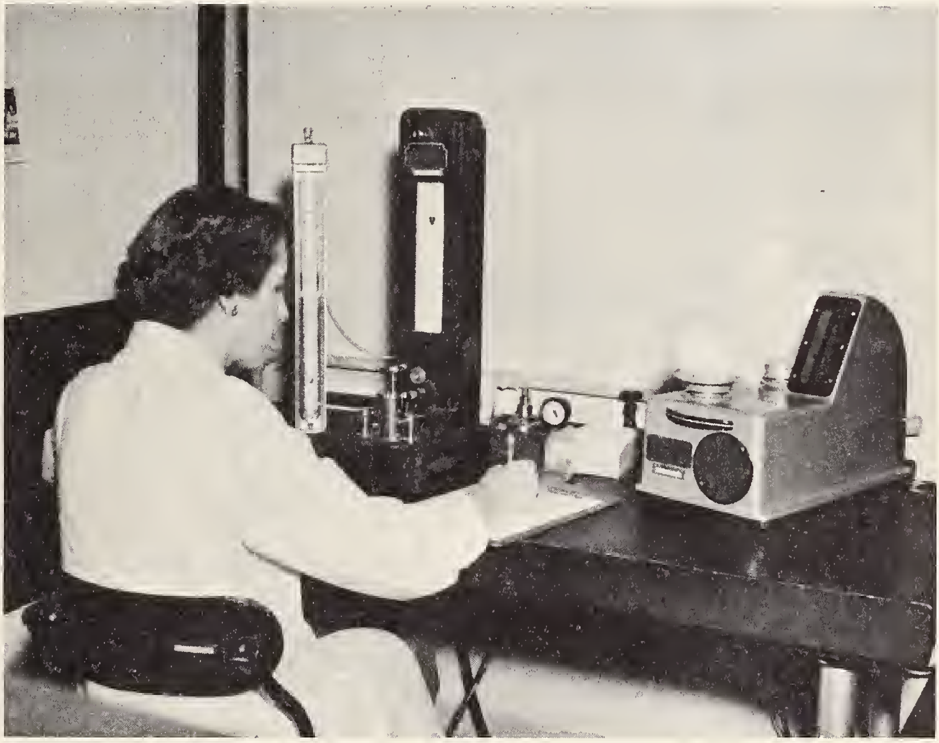

Figure 8.--Technician performing fiber fineness and maturity tests using the Micronaire instrument.

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[2] Webb, Robert W., and Burley, Samuel T., Jr. The Causticaire Method for Measuring Cotton-Fiber Maturity and Fineness: Improvement and Evaluation. U. S. Dept. Agr., Agr. Mkt. Service. December 1953.

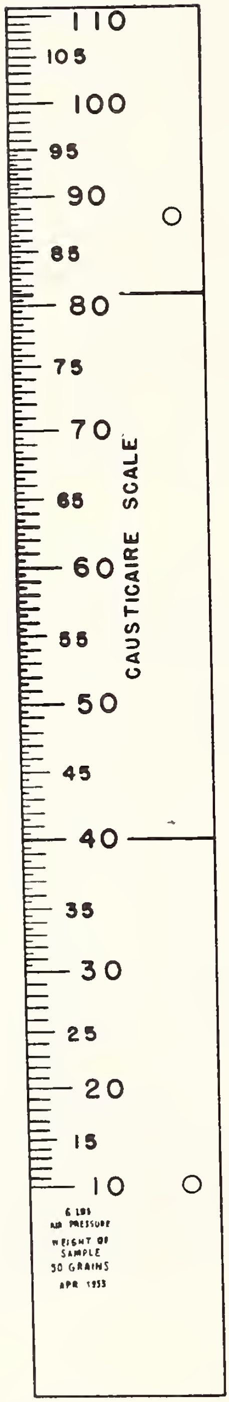


Figure 9.--Causticaire scale for the Micronaire instrument.

As a rule, long-staple cottons are fine-fibered and short-staple cottons are coarse-fibered (fig. 10). Fiber fineness contributes to yarn strength, particularly when fine numbers are spun. Fine fibers, however, tend to increase neppiness and to require a reduced rate of processing, so that the desirability of fiber fineness depends on the specific end product or use.

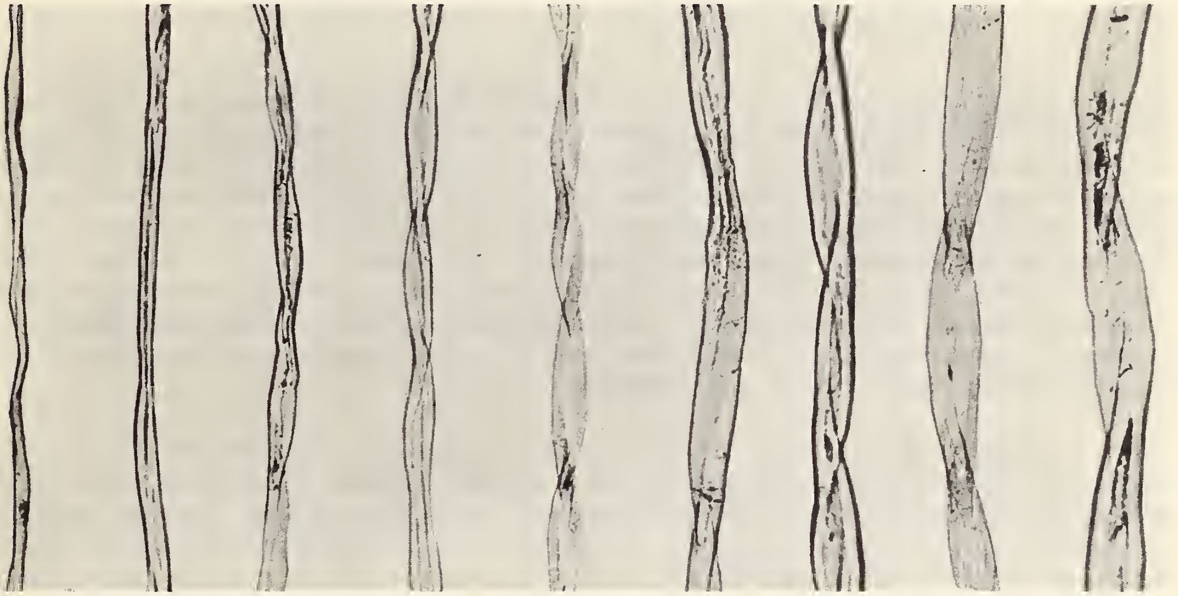


Figure 10.--Reproduction of raw cotton fibers showing gradations in fineness found in American upland cotton (about 230X).

For American upland cottons, the following adjective ratings may be applied for purposes of comparisons:

Fiber fineness
(Micrograms per inch of fiber)

Below 3.0	Very fine
3.0 to 3.9	Fine
4.0 to 4.9	Average
5.0 to 5.9	Coarse
6.0 and above	Very coarse

Fiber maturity is an important factor affecting the appearance of yarns and fabrics. Immature fibers are susceptible to the formation of neps. Cottons differing in degree of maturity do not dye uniformily. Statistical analyses have also indicated that fiber maturity is a desirable characteristic from the standpoint of low picker and card waste. The following descriptive terms may be applied to classify cottons with respect to Causticaire maturity index:

Causticaire fiber maturity
(index)

82 and above	Mature
76 to 81	Average
70 to 75	Immature
Below 70	Very immature

Averages reported for Causticaire fineness and maturity are based on two determinations. A special study indicated that the accuracy of the reproducibility of the results for such tests is as follows:

Item	Standard error
Fineness (Causticaire)	± 0.05
Maturity (Causticaire)	± 0.7

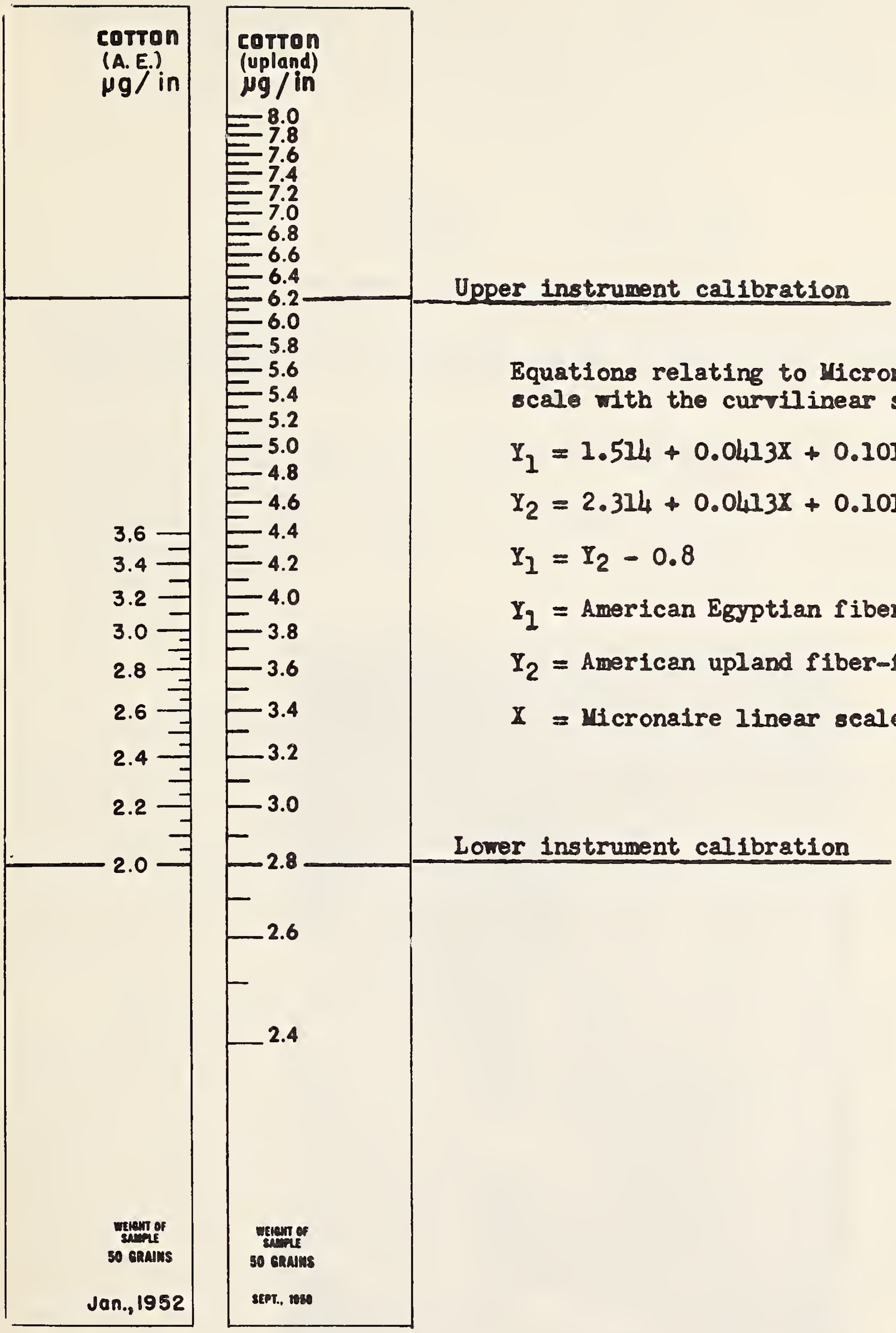
Micronaire tests (6.1 and 6.2).--The Micronaire items are more rapid than the Causticaire item for fineness and maturity because only the untreated samples are tested. Micronaire results, however, reflect fineness and maturity in combination instead of providing separate measurements for these two properties. A linear scale for the Micronaire was initially adopted to indicate a direct reading in micrograms-per-inch. Further studies, however, indicated a curvilinear relationship between Micronaire readings and actual array-weight-per-inch determinations on American upland cottons. As a result of these studies, a curvilinear Micronaire scale for upland cotton was adopted in September, 1950.

Studies of the adaptability of the Micronaire for measuring of American Egyptian and other extra long staple cottons indicated that neither the original linear scale nor the revised scale for upland cottons gave satisfactory results in relation to actual weight-per-inch for such cottons. A separate scale developed specifically for these cottons was, therefore, adopted in January 1952. The two scales now being used for Micronaire fineness are shown in figure 11. The discussion of the fineness results and the adjective ratings listed for the Causticaire method also apply to fiber fineness by the Micronaire method.

Averages reported for test item (6.1) are based on two determinations. In the case of item (6.2), however, one determination on each of two or more subsamples are averaged to obtain a representative value for the entire group of replicate subsamples. A special study indicated that the accuracy of the reproducibility of the results for the Micronaire test is as follows:

Item	Standard error
Micronaire units	± 0.05

Fiber fineness and maturity (array) (6.3).--This is a slow and tedious item which requires that two fiber-length arrays be made. Approximately 100 fibers are extracted from each 1/8-inch length array group for the tests. These fibers are weighed and are examined under high-power magnification after the fiber walls are swollen by applying an 18-percent solution of sodium hydroxide. In this examination, the thickness of the cell walls in relation to the lumen is determined for each fiber and the number of both the thick-walled fibers and the thin-walled fibers are counted. The average fineness, or weight-per-inch, of fiber in the sample is calculated and expressed in terms of micrograms-per-inch of fiber. The average maturity or proportion of thick-walled fibers is calculated and expressed in terms



Equations relating to Micronaire linear scale with the curvilinear scales:

$Y_1 = 1.514 + 0.0413X + 0.101X^2$

$Y_2 = 2.314 + 0.0413X + 0.101X^2$

$Y_1 = Y_2 - 0.8$

Y_1 = American Egyptian fiber-fineness

Y_2 = American upland fiber-fineness

X = Micronaire linear scale (inches)

Figure 11.--Micronaire scales for both American upland and American Egyptian cottons.

of percentage of mature fibers. The discussion of fiber fineness and the adjective ratings listed above for the Causticaire method also apply to the array method. The following descriptive terms may be applied to classify cottons with respect to array maturity:

Array fiber maturity (percent)	
Above 85	Mature
76 to 85	Average
66 to 75	Immature
65 and below	Very immature

Averages reported for fiber fineness and maturity by the array method (item 6.3) are based on two determinations which have been shown by statistical studies to be necessary for reliable results.

Nep content of ginned cotton lint (7).--In this item a 3-gram sample is blended on the mechanical blender. This blended sample is then processed into a thin web (40 grains per yard) using special equipment (fig. 12) developed for this purpose. The neps in ten 4 x 9-inch specimens of the web are counted by each of two technicians and the results are expressed in terms of number of neps in 100 square inches of web.

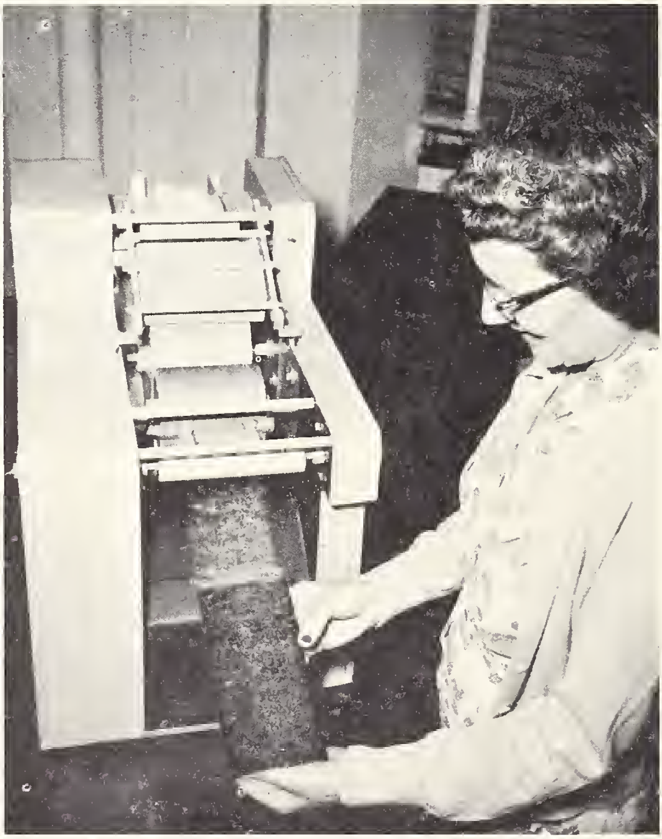


Figure 12.--Technician performing tests for determining nep content of cotton lint using the nep test machine.

The following adjective descriptions will serve to classify cottons with respect to nep content:

Number of neps per 100 square inches of web
(prepared on accessory to the mechanical fiber blender)

Low...............	10 and below
Average...........	11 to 20
High..............	21 to 30
Very high.........	31 and above

Statistical analyses have shown that raw stock nep content explained more of the variance in carded yarn appearance than spinning test evaluations of neps in card web. The accuracy of the reproducibility of the results for nep content tests have been calculated for various levels of neps to be, as follows:

Neps per 100 square inches of web	Standard error
10	± 1.7
20	± 2.4
30	± 2.9
40	± 3.3
50	± 3.7
60	± 4.1

Furnishing check test samples (8).--This test item has been offered to meet the needs of a number of applicants who operate their own laboratories. A 1-pound sample of short, medium, or long staple American upland cotton or extra long staple American Egyptian cotton is furnished for laboratory check tests. With each of these samples are also furnished data with respect to test results obtained in the Cotton Division laboratories. This affords the applicant an opportunity to correlate the results obtained in his laboratory with those obtained in the Cotton Division laboratories.

Blending samples for fiber tests (9).--In view of the relatively small quantity of cotton used as specimens with many laboratory test instruments, it is highly important that these specimens be representative of the entire sample. To accomplish this, 32 pinches of cotton are taken at random from different parts of the sample provided and these pinches are blended on a mechanical blender (fig. 13). The blender mixes the individual fibers into a practically homogeneous mass and specimens taken from any part of the blended sample are representative. Specimens for the fiber tests described above, except for the subsample items (3.1, 5.1, and 6.2), are taken from a mechanically blended sample. Item (9) provides a means for the applicant to obtain a mechanically blended sample for fiber tests in his own laboratory.

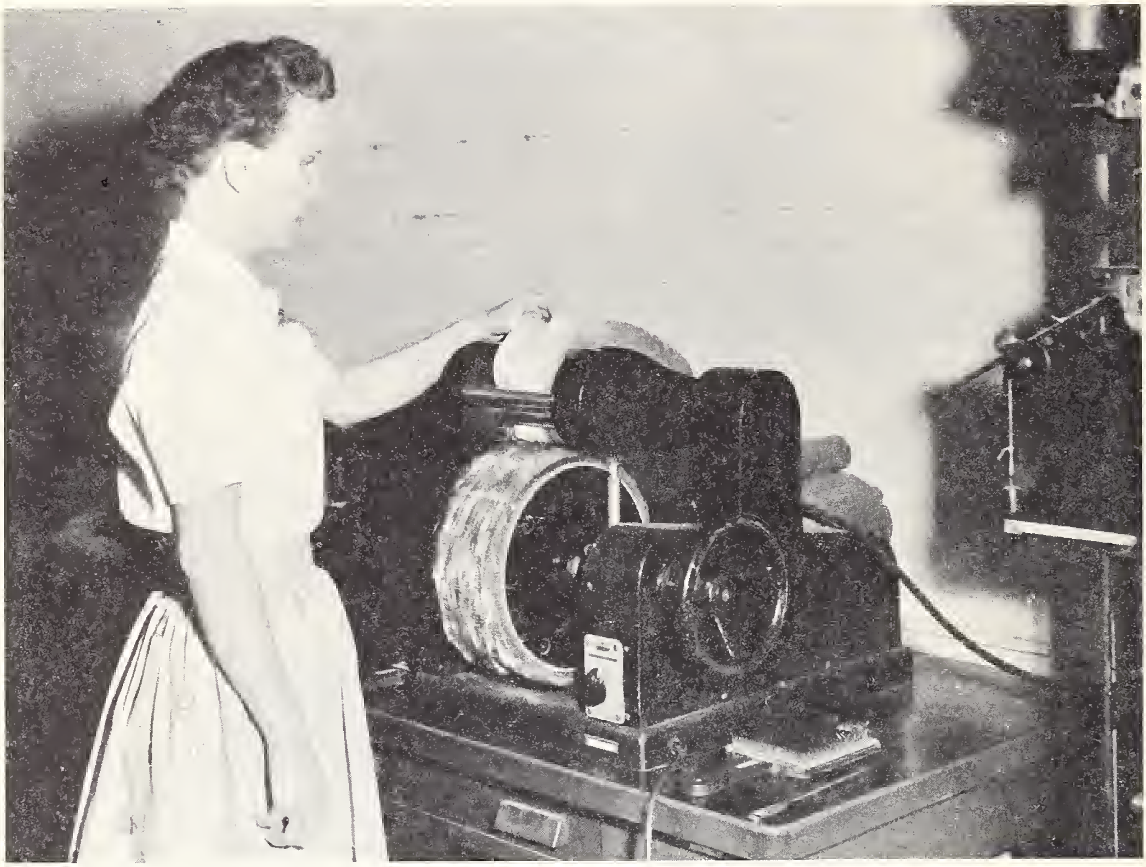


Figure 13.--Technician blending a sample of cotton lint using the mechanical cotton fiber blender.

Determination of moisture content (10a).--This item consists of the weighing and drying of samples of ginned cotton lint, cotton stock at various stages of processing, cotton yarn, or cotton manufacturing waste. The samples are dried in drying ovens (fig. 2), and the moisture content is calculated by using the following formula:

$$\text{Moisture content percentage} = \frac{\text{Original weight} - \text{dry weight} \times 100}{\text{Original weight}}$$

The moisture content percentage is reported for each sample.

Sugar content (22).--This item consists of chemical-colorimetric tests (fig. 14) for soluble reducing sugar content as an indication of honeydew contamination. High sugar content is associated with difficulty in textile processing and with lower yarn appearance grades. Inasmuch as the sugar content of cotton decreases as the fibers mature, a relatively high sugar content for the cotton of normal maturity indicates contamination with honeydew. The presence of a relatively high concentration of sugar in immature cottons, however, may be attributable either to fiber immaturity, honeydew, or both. Although the critical point in sugar content has not been established definitely from the standpoint of adverse effect on textile processing, this point is probably in the neighborhood of 0.3 percent reducing sugar. Cottons with sugar content in excess of that percentage may give trouble in processing.

Color (23).--This item includes reflectance in terms of R_d values and the degree of yellowness in terms of b values as measured by an automatic electronic instrument, the Nickerson-Hunter Cotton Colorimeter (fig. 15). The R_d scale measures percentage of reflectance from 0 to 100 and the b scale provides a measure of yellow to blue. The portion of the b scale used on the cotton colorimeter indicates an increasing degree of yellowness as the scale number increases. The color values obtained may be plotted on a special color diagram (fig. 16) for comparison with the color of the cotton in the official grade standards. Actual color diagrams of standards purchased by the applicant may also be obtained by requesting item(23.1). Item(23.2)includes a set of color standards and a master diagram for use in calibrating Nickerson-Hunter Cotton Colorimeters.

Shirley Analyzer item (25).--In this item, a sample of ginned cotton lint or cotton waste is weighed and processed through the Shirley Analyzer (fig. 17). This machine makes an almost perfect separation of lint and trash. The percentage of nonlint content is reported. Nonlint removed by the Shirley Analyzer differs from total picker and card waste (item 11 through 14) in that it contains practically no fiber, whereas, an appreciable quantity of fiber is removed as waste in mill cleaning machines. Since both ginned lint and various types of mill wastes can be analyzed, this item is useful for a number of research purposes. The cleaned lint and/or the trash removed are returned to the applicant for his inspection and use when specifically requested in accordance with the provisions of item (26).

On the basis of tests made on bales used in the white grade standards, the following scale has been established to represent percentages of nonlint removed by the Shirley Analyzer from different grades:

Grade	Nonlint content Percent
Strict Good Middling.....	2.0
Good Middling............	2.4
Strict Middling..........	2.9
Middling.................	3.7
Strict Low Middling......	5.1
Low Middling.............	7.6
Strict Good Ordinary.....	11.0
Good Ordinary............	17.0

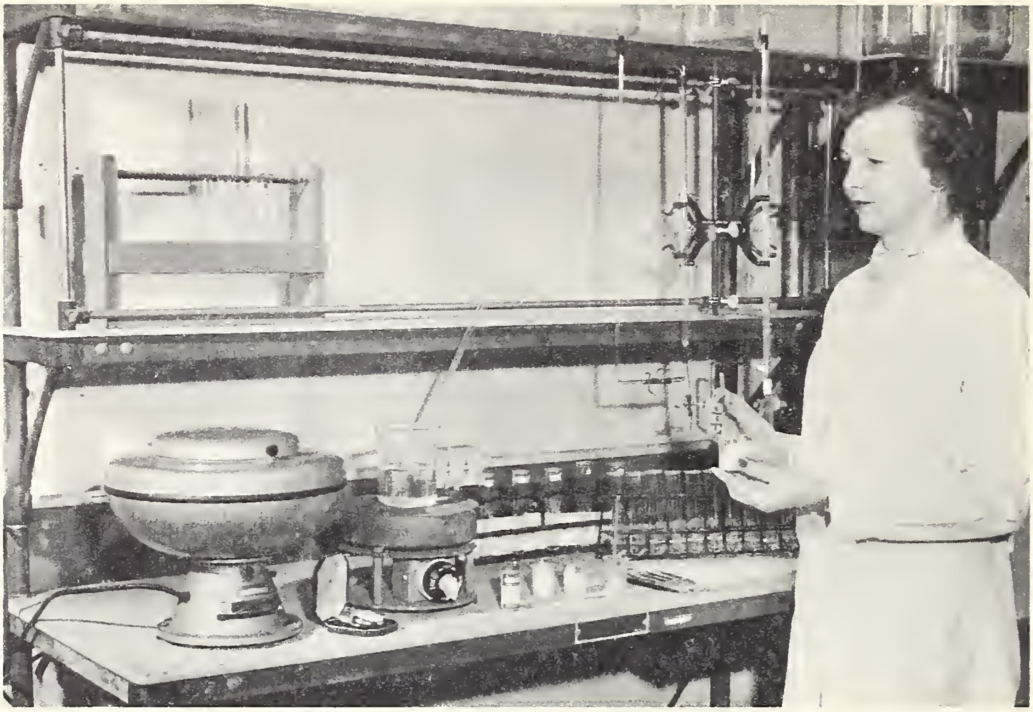


Figure 14.--Technician performing chemical-colorimetric tests for determining sugar content of cotton lint.

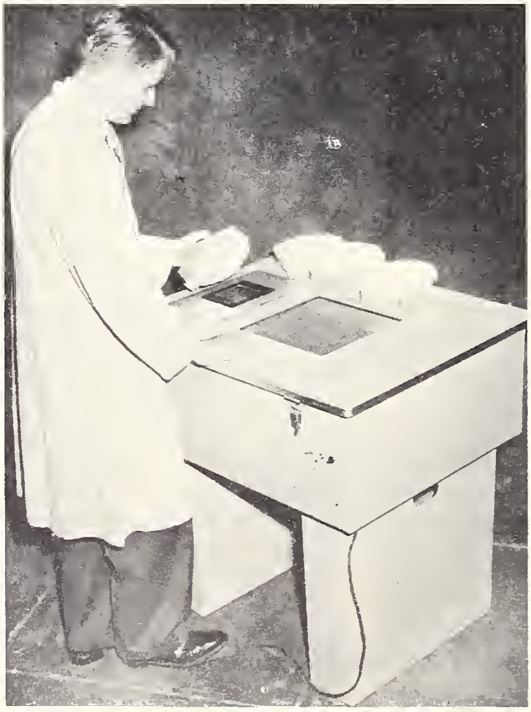


Figure 15.--Technician performing tests for determining the color of cotton lint using the Nickerson-Hunter Cotton Colorimeter.

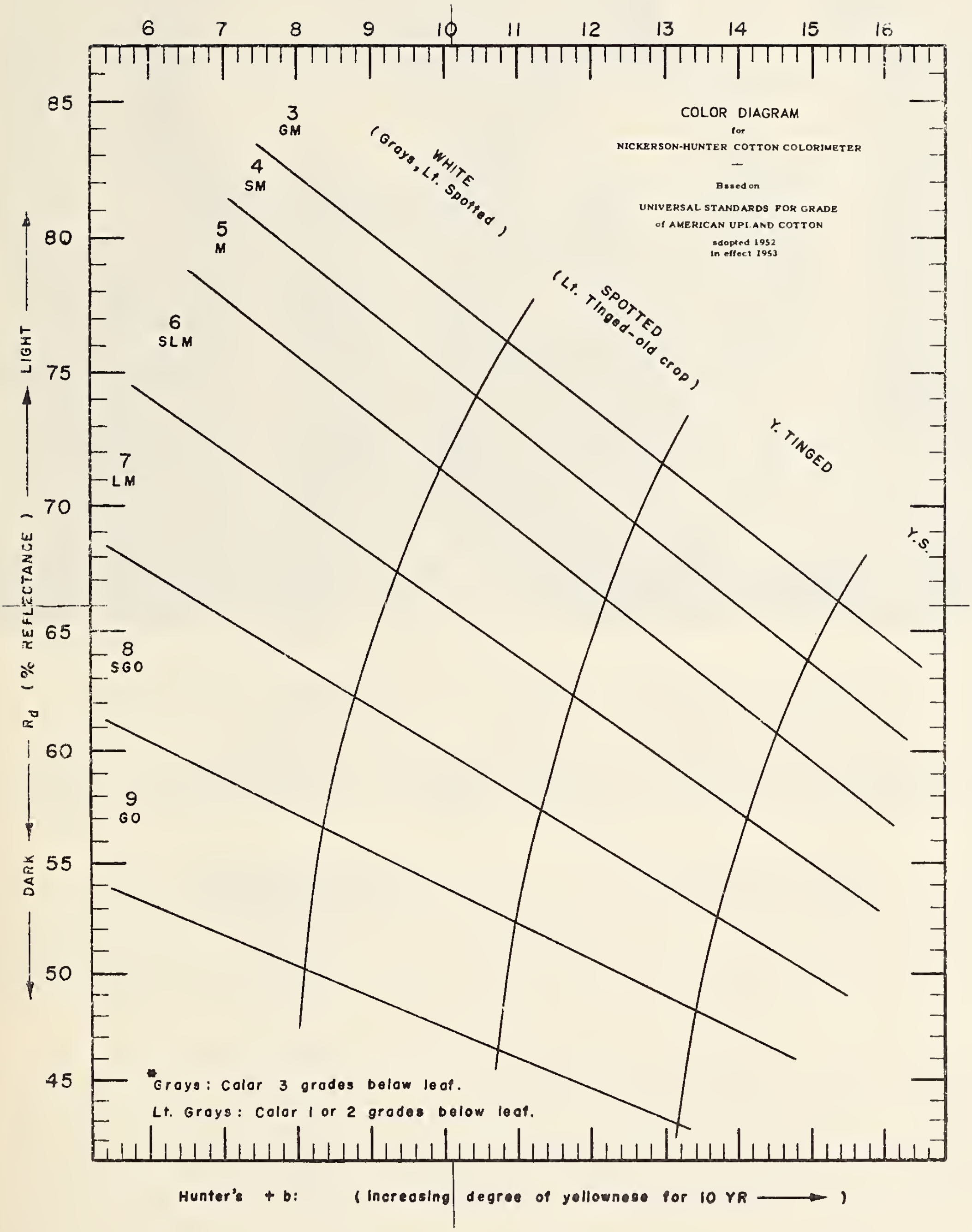


Figure 16.--Color diagram for Nickerson-Hunter Cotton Colorimeter.

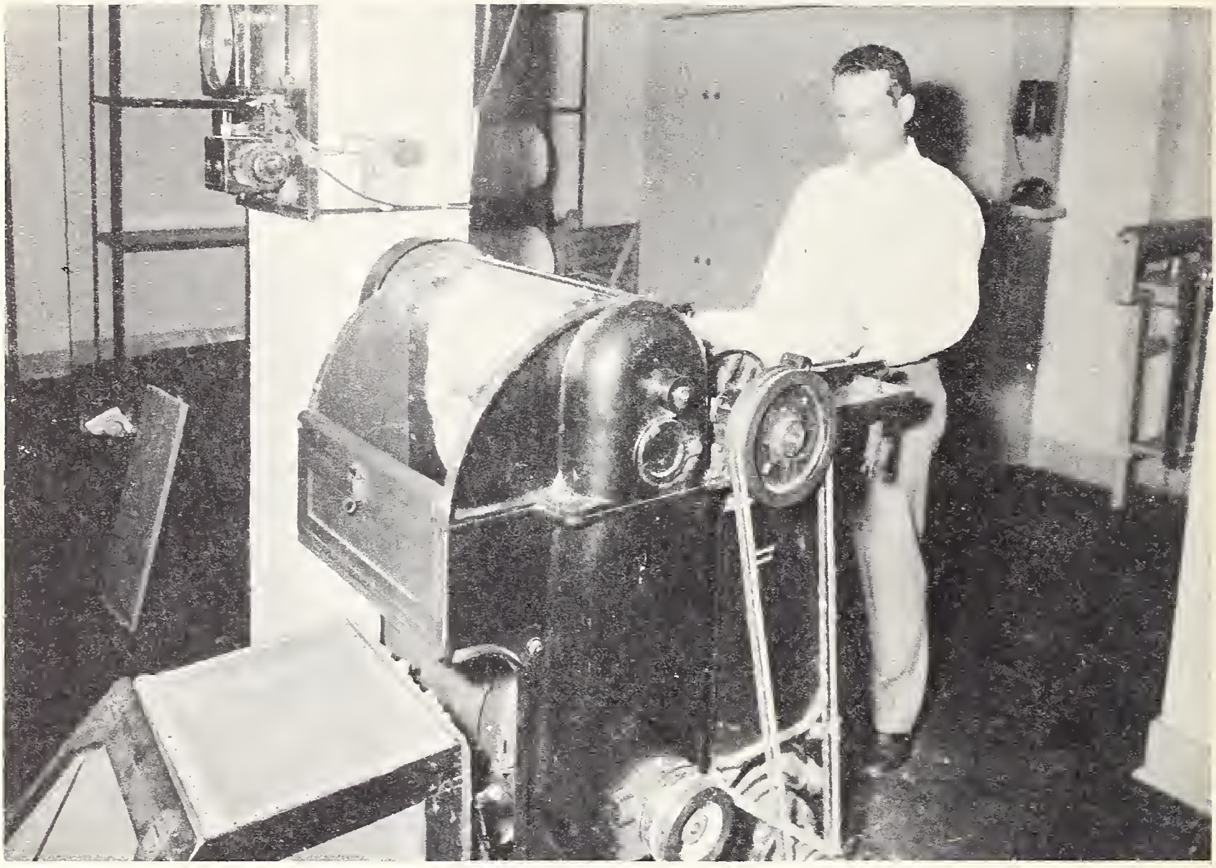


Figure 17.--Technician performing tests for determining the nonlint content of cotton lint using the Shirley Analyzer.

By similar tests, the following scale has been developed to represent the grades for American Egyptian cotton:

Grade of cotton	Nonlint content Percent
1	1.9
2	2.4
3	3.3
4	4.7
5	6.5
6	8.8
7	11.5
8	14.7
9	18.3

The foregoing tabulations were derived from smoothed curves drawn on the basis of these data. Differences in results obtained for individual samples and percentages shown may be caused by the following: (1) There are intentional allowances for variations in trash content among bales in each standard grade (to offset differences in color and provide a range for the grade) that may amount to an overlap, particularly in the higher grades; and (2) the tabulation figures are based on weight and they do not take into consideration the nature of trash, which is sometimes as important as weight in determining the grade designation.

Nonlint content results obtained in the laboratories of the Cotton Division for cottons which have been tested over a period of years provide an indication of the reproducibility of results for the Shirley Analyzer test as follows:

Item	Standard error
Nonlint content (percent)	± 0.4

Classification for grade and staple length (28).--The classification is based on the official cotton standards for grade and staple length.

Processing Tests and Their Evaluation

In the final analysis, the actual results obtained in processing different samples of cotton and in the testing of the resulting yarns provide the most satisfactory basis for evaluating the relative merits of the cottons represented by such samples. Laboratory equipment and techniques have now been developed to a point where reliable spinning tests results can be obtained from small samples of cotton using commercial-type processing machinery. A brief description of these processes are given in subsequent paragraphs.

In these tests, the test sample is opened by hand and processed through a finisher picker (fig. 18). This machine cleans the cotton with a rotary beater, screens, and air draft. The sample is collected on a condenser screen and is delivered in the form of a layer which is called a lap.

The lap from the picker is processed through a card (fig. 19). This machine disentangles the mass of fiber and removes fine trash, other particles of foreign material, and some fiber. The disentangled fibers are condensed first into a thin layer called a web and then into a rope-like strand called a sliver.

For combed yarn tests, the card sliver is processed first through a sliver lapper (fig. 20), and then through a ribbon lapper (fig. 21), before being fed to the comber. These two machines combine a number of strands for uniformity and draft or draw out the fibers to make them more parallel. The sample from the ribbon lapper is processed through the comber (fig. 22). This machine combs out short fibers and forms the remaining fibers into sliver.

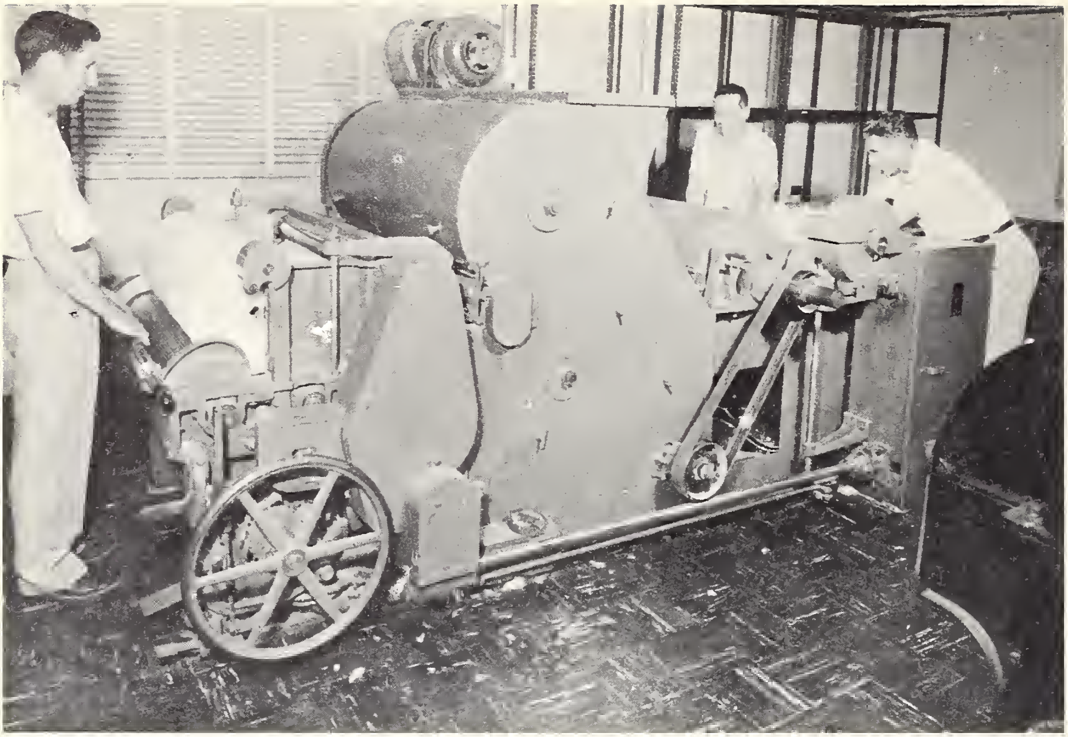


Figure 18.--Technicians processing a test sample of cotton through the picker.

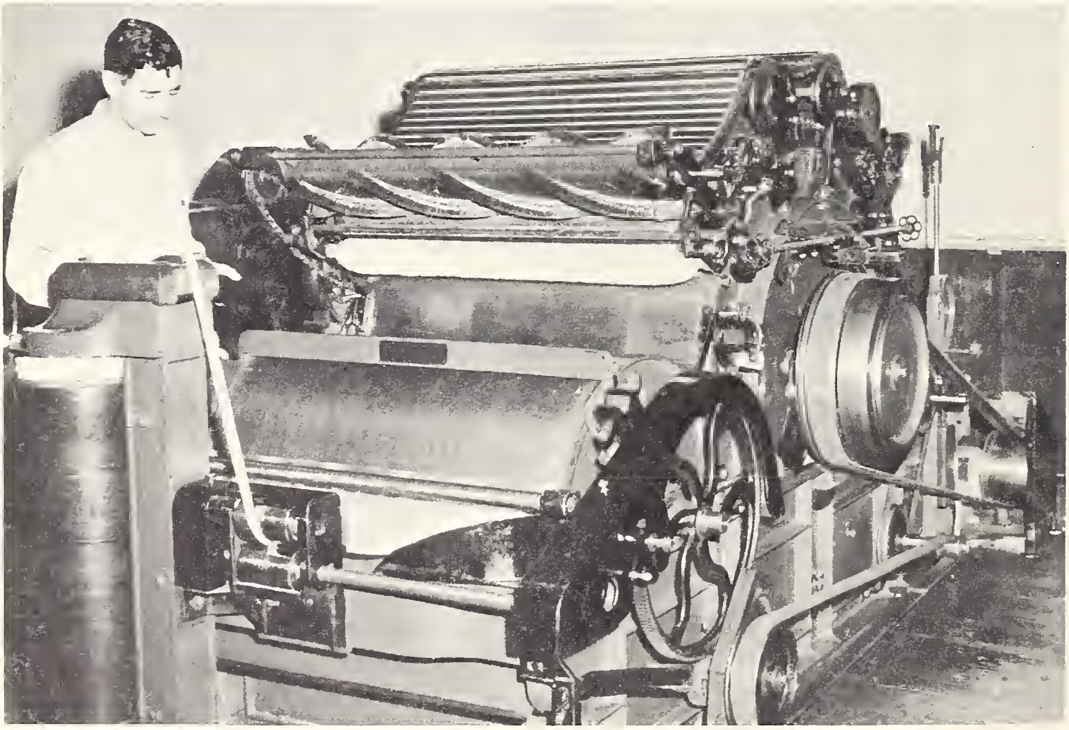


Figure 19.--Technician processing a test sample of picker lap through the card.

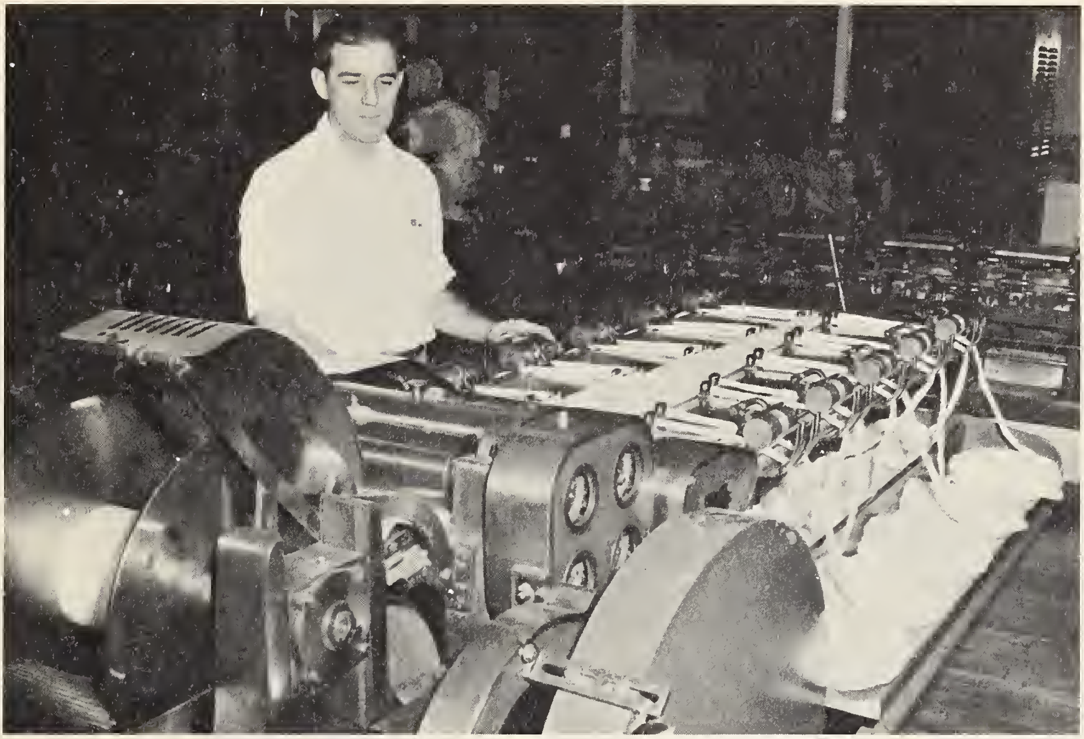


Figure 20.--Technician processing a test sample of card sliver through the sliver lapper.

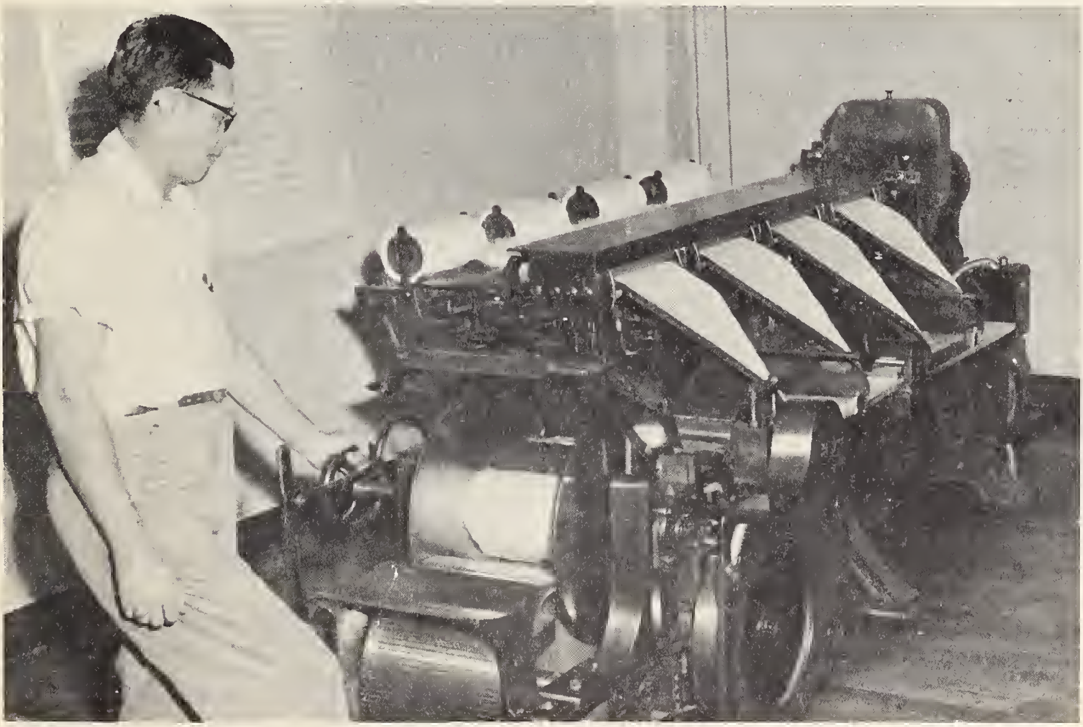


Figure 21.--Technician processing a test sample of sliver lapper laps through the ribbon lapper.

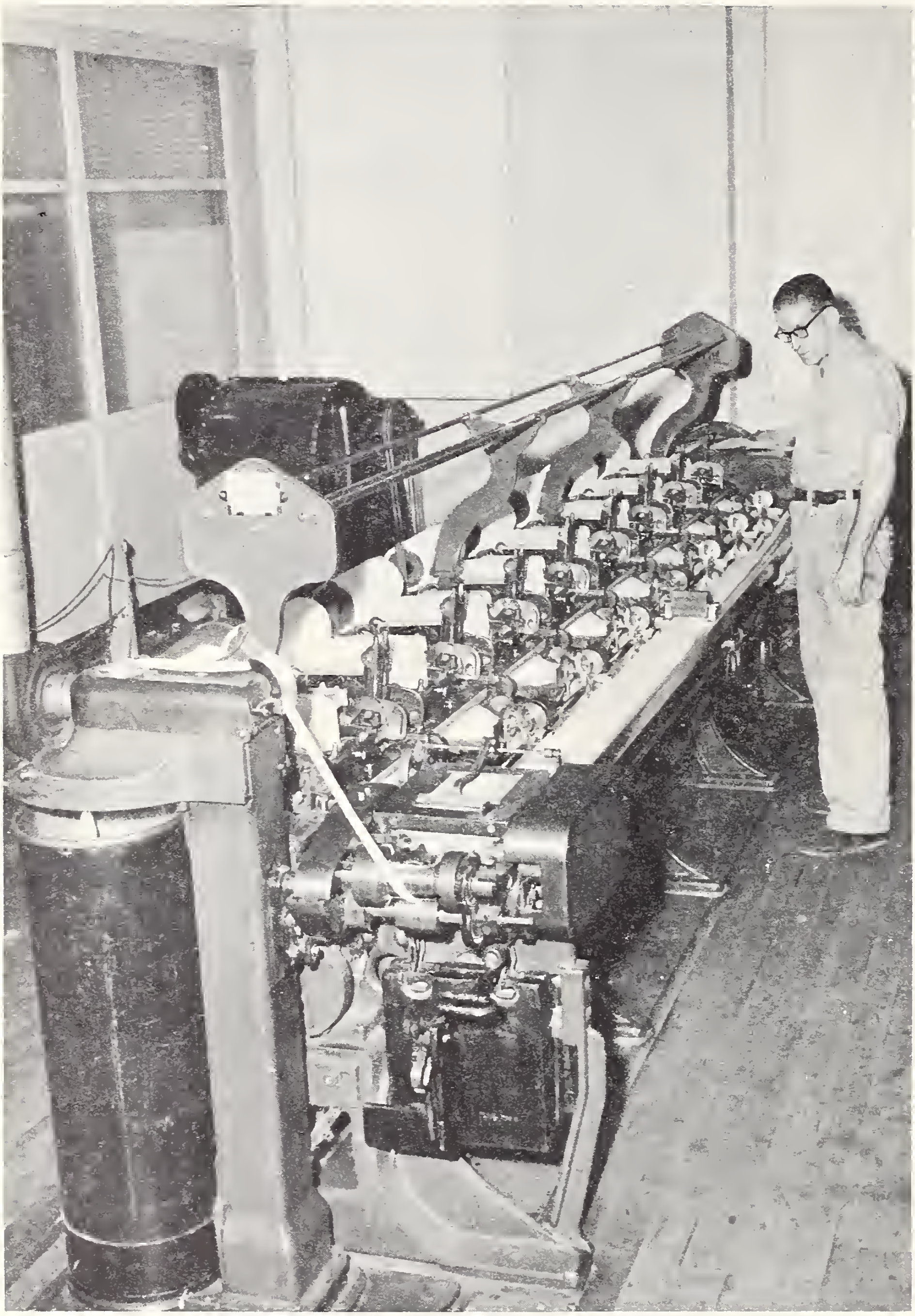


Figure 22.--Technician processing a test sample of ribbon lapper laps through comber.

Either the card sliver for carded yarns or the comber sliver for combed yarns is fed to a drawing frame (fig. 23). This machine combines a number of strands for uniformity and drafts or draws out the fibers to make them more parallel and delivers them as sliver. One process of drawing is used for combed yarns and two processes of drawing are used for carded yarns.

The drawing sliver is processed through a roving frame (fig. 24). This machine drafts or draws out the fibers into a much smaller strand, inserts enough twist to give adequate strength for further handling, and winds the strand onto a bobbin. This slightly twisted strand is called roving. Only one process of roving is used except for the fine combed yarns which require a second process (fig. 25) to further reduce the size of the strand.

The roving is processed through a spinning frame (fig. 26). This machine drafts or draws out the strand to the size or yarn number required, inserts twist to form a firm strand, and winds it onto bobbins. This firmly twisted strand is called yarn. Most spinning test quality evaluations are made on the yarn produced by the spinning frame.

When ply yarn evaluations are desired, however, two or more strands of yarns are processed through a twister (fig. 27). This machine inserts twist into the multiple strands to form a ply yarn and winds it onto bobbins. Unless otherwise specified, reverse twist is inserted at the twister in order to produce a balanced yarn.

When fabric evaluations are desired, the warp yarns from the spinning frame are processed through a combination warping and slashing operation using a laboratory type machine (fig. 28). This machine treats the yarn with a sizing solution consisting of starch and other ingredients, drys the treated yarn, and winds the desired number of ends on a loom beam. The sizing treatment increases the resistance to chafing during the weaving operation. Also, the filling yarns from the spinning frame are wound into special packages to fit the shuttle of the loom (fig. 29). These warp yarns from the slasher and filling yarns from the winder are processed through a narrow loom (fig. 30). This machine interweaves the warp yarns, which run lengthwise, and filling yarns, which run crosswise, to produce cloth or fabric. The grey or unfinished cloth which is only 12 inches wide is wound on a cloth roll as it is woven. This cloth is usually evaluated for quality in the grey or unfinished state, but it may be subjected to various dyeing and finishing treatments before the quality evaluations are made.

The processing tests are performed in the following controlled atmospheric conditions:

1. Picking, carding, combing, drawing, and roving processes at 60 percent relative humidity ± 2% and 75 degrees F. ± 2°.
2. Spinning process at 65 percent relative humidity ± 2% and 75 degrees F. ± 2°.
3. Weaving process at 80 percent relative humidity ± 2% and prevailing temperature.
4. Testing room at 65 percent relative humidity ± 2% and 70 degrees F. ± 2°.

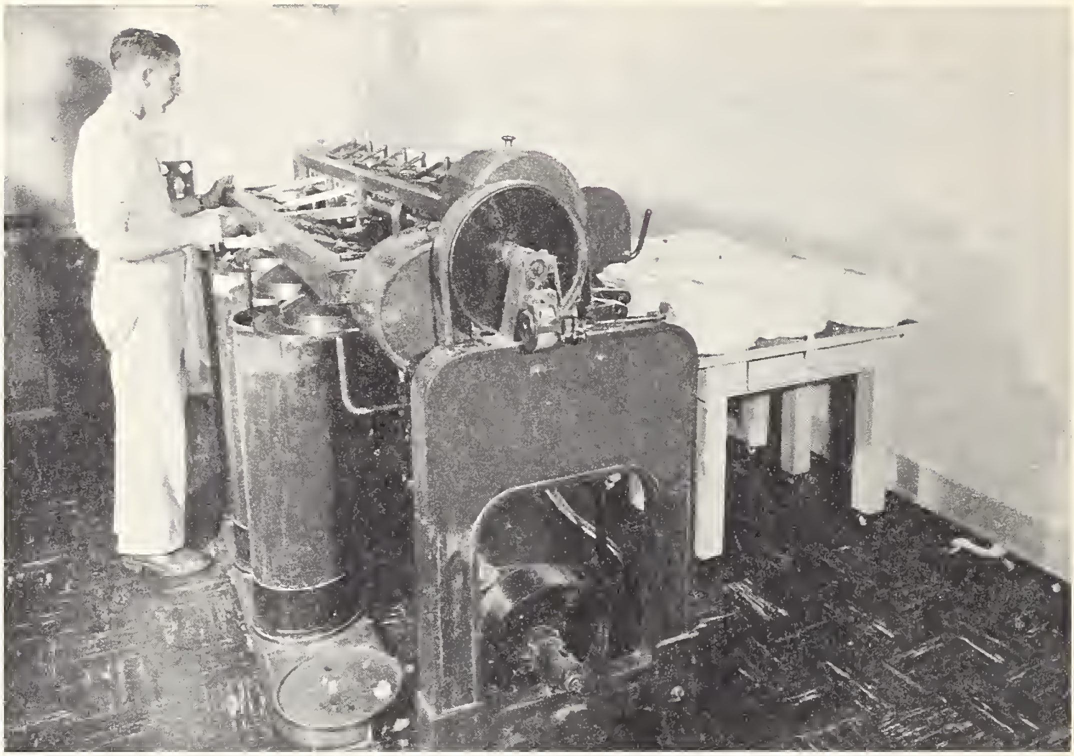


Figure 23.--Technician processing a test sample of card sliver or comber sliver through the drawing frame.

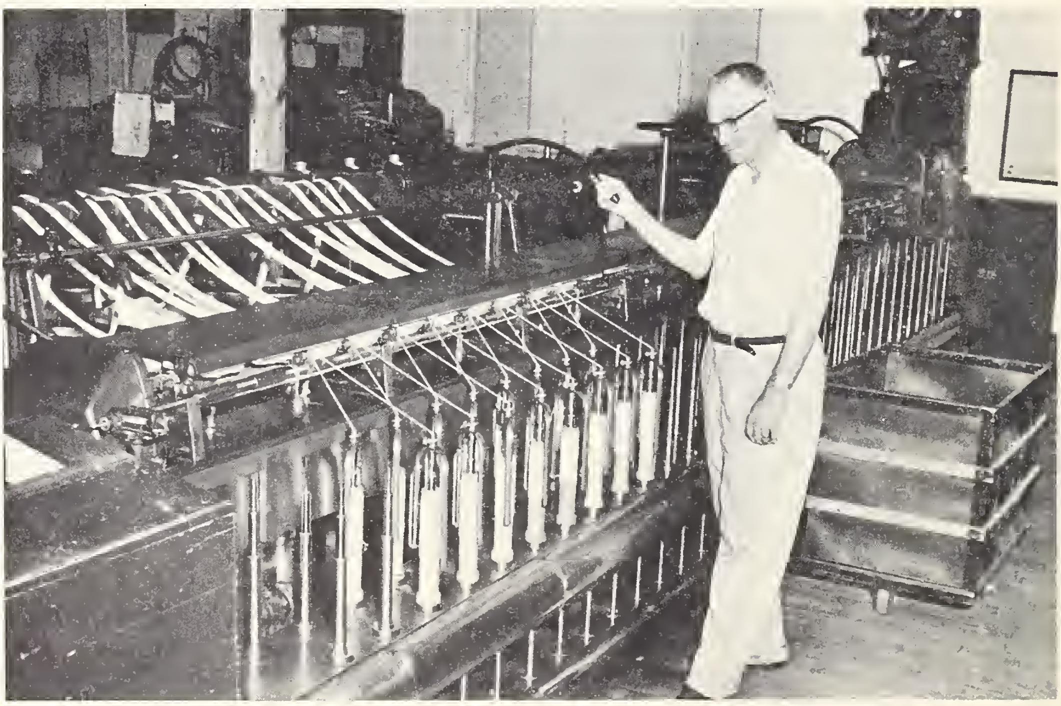


Figure 24.--Technician processing a test sample of drawing sliver through the roving frame.

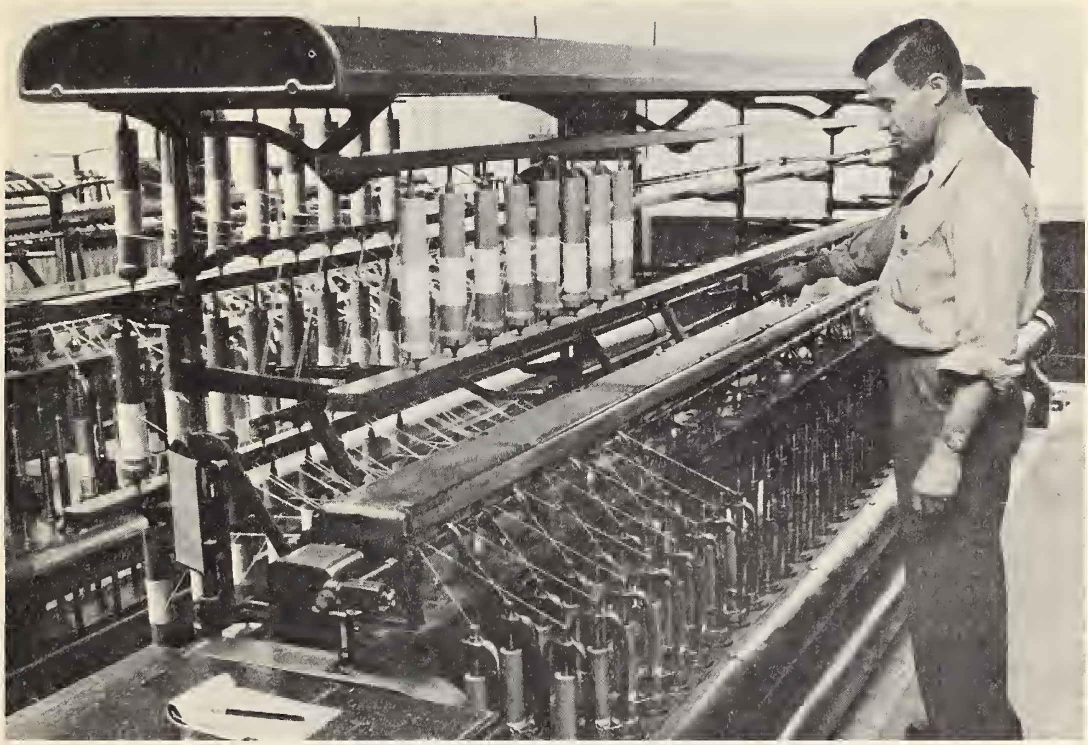


Figure 25.--Technician processing a test sample of roving through a second roving frame for fine combed yarn numbers.

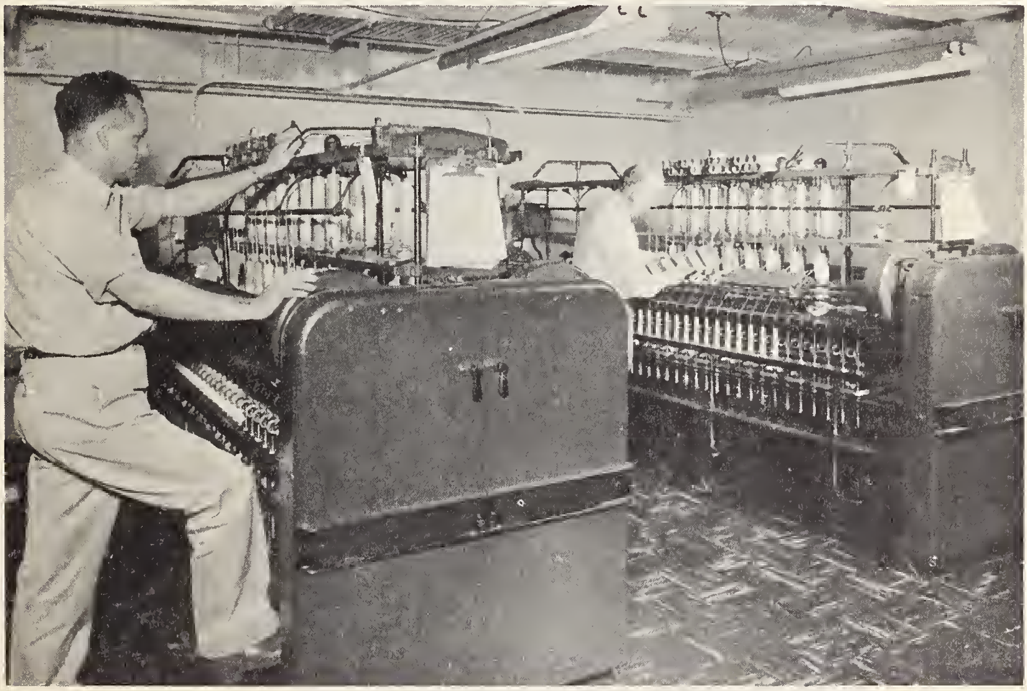


Figure 26.--Technicians processing test samples of roving through the spinning frame.

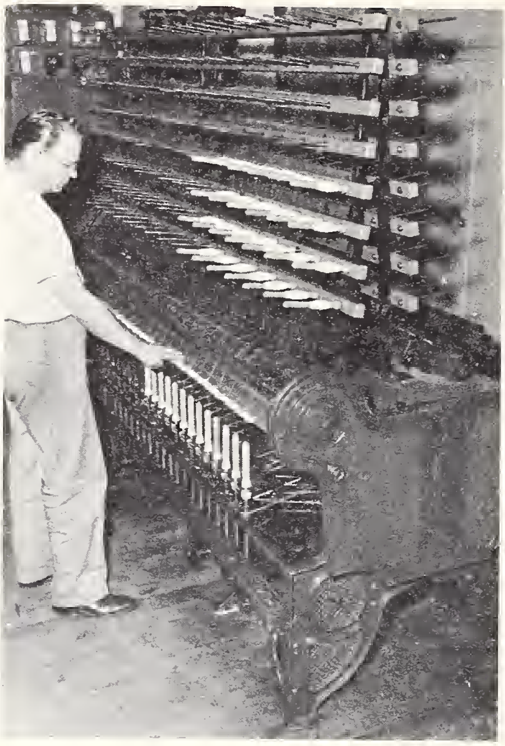


Figure 27.--Technician processing a test sample of yarn through the twister.

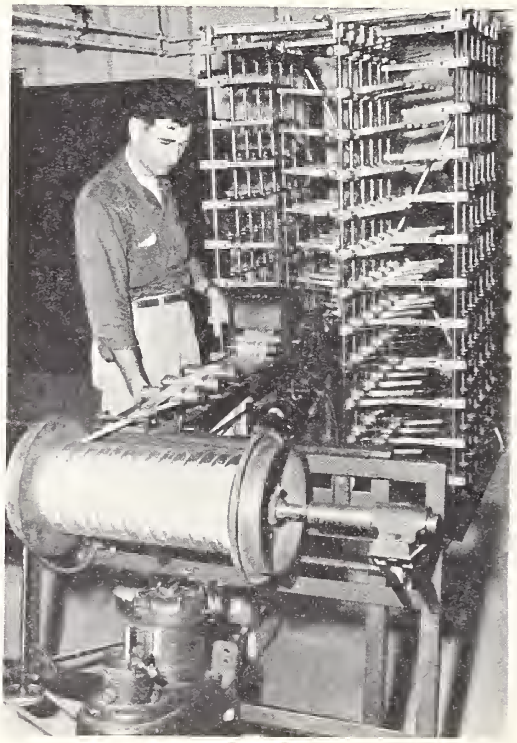


Figure 28.--Technician processing a test sample of warp yarn through the warper slasher.

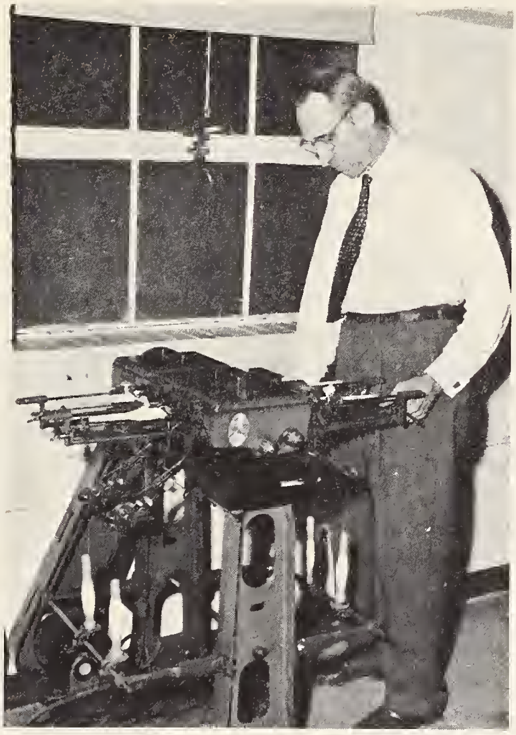


Figure 29.--Technician processing a test sample of filling yarn on the winder.

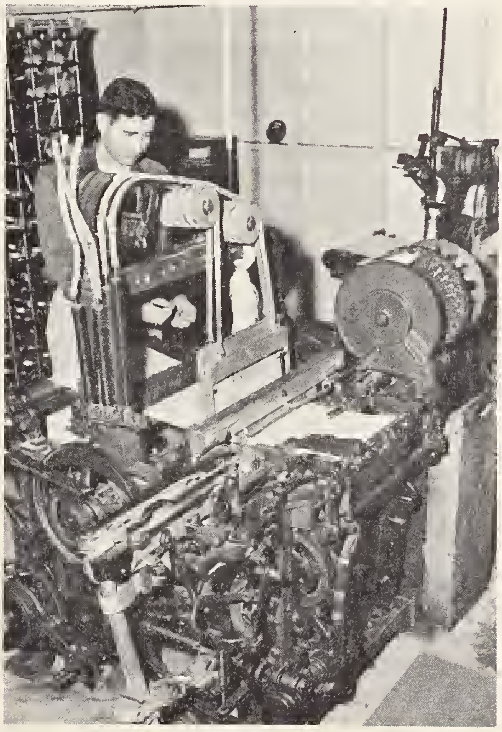


Figure 30.--Technician processing a test sample of warp and filling yarn into cloth on the loom.

Spinning tests (items 11 through 15) are provided for carded yarns, combed yarns, and combinations of both carded and combed yarns. In commercial practice, most cottons 1-1/8 inches and longer are manufactured into combed yarns. Although a considerable quantity of cotton shorter than 1-1/8 inches is used for combed yarns, the major part of it is used for carded yarns. Applicants for spinning tests should indicate in each instance whether a carded test, a combed test, or a combination of these two tests is desired.

The range of yarn numbers that can be spun from a cotton is dependent on its fiber length and other properties usually associated with length. Also, the quality requirements are generally higher for products made from the finer yarn numbers than they are for products made from coarser yarn numbers. The finer numbers are, therefore, generally spun commercially from the longer staple cottons at relatively low-production rates; the coarser numbers are generally spun commercially from the shorter staple cottons at relatively high production rates. In order to more nearly approach commercial practice, four standard organizations for processing cotton into yarn, have been set up to cover the range of staple length of cottons normally grown in this country. Each of these organizations include two yarn numbers to provide data in terms of a relatively wide range. Table 2 shows yarn numbers, finest yarn number to spin, twist multiplier, carding rate, and comber settings that have been adopted as standard for various fiber lengths. Other details for each of the four organizations are shown in table 3.

The use of the standard organization, as based on the fiber length of a particular sample, is desirable in order that specific test results may be interpreted on the basis of research and other data accumulated over a period of years. Any two standard laboratory yarn numbers (8s, 14s, 22s, 36s, 44s, 50s, and 60s carded or 14s, 22s, 36s, 44s, 50s, 60s, 80s, and 100s combed) that are within the spinnable limits of the particular cotton may, however, be specified by the applicant. The two standard yarn numbers selected are spun with the optimum twist multiplier for the fiber unless otherwise specified. Any one of the standard carding rates (6-1/2, 9-1/2, and 12-1/2 lb./hr. for carded yarns or 3-1/2, 6-1/2, and 9-1/2 lb./hr. for combed yarns) and any one of the standard comber settings (0.42, 0.48, and 0.54 inch to extract an estimated 12, 15, or 18 percent comber waste, respectively) may also be specified by the applicant. Unless the tests are performed according to the standard procedures as based on the fiber length of the particular sample, however, the general interpretation of results as listed in subsequent paragraphs is not applicable.

The spinning test reports include the following:

1. Grade and staple classification of the cotton.
2. Upper half mean length, mean length, and uniformity ratio as determined by the Fibrograph.
3. Weight of cotton fed to the first picker.
4. Carding rate, picker and card waste percentage, and neps per 100 square inches of card web.
5. Comber setting and comber waste percentage when combed yarn tests are made.

Table 2.--Yarn numbers, finest yarn number to spin, twist multiplier, carding rate, and comber setting which have been adopted as standard for various fiber lengths

Upper half mean length (Fibrograph)	Standard yarn numbers		Finest standard yarn number 1/	Standard twist multiplier	Standard carding rate	Standard comber setting
	Low	High				
Inches	Number	Number	Number	Number	lb./hr.	Inches
Organization I - Carded yarns only:						
0.62 and below	8s	22s	22sK	5.35	12-1/2	
.63 to .66	8s	22s	22sK	5.15	12-1/2	
.67 to .70	8s	22s	36sK	5.00	12-1/2	
.71 to .74	8s	22s	36sK	4.85	12-1/2	
.75 to .78	8s	22s	36sK	4.70	12-1/2	
.79 to .82	8s	22s	36sK	4.60	12-1/2	
.83 to .86	8s	22s	44sK	4.45	12-1/2	
.87 to .89	8s	22s	44sK	4.35	12-1/2	
.90 to .93	8s	22s	44sK	4.25	12-1/2	
.94 to .97	8s	22s	44sK	4.20	12-1/2	
Organization II - Carded yarns (also combed yarns when specified):						
0.98 to 1.01	22s	50s	50sK-60sC	4.10	9-1/2	0.42
1.02 to 1.05	22s	50s	50sK-60sC	4.05	9-1/2	.42
1.06 to 1.09	22s	50s	50sK-60sC	3.95	9-1/2	.42
1.10 to 1.13	22s	50s	50sK-60sC	3.90	9-1/2	.42
Organization III - Carded and combed yarns:						
1.14 to 1.16	22s	50s	60sK-80sC	3.85	6-1/2	0.48
1.17 to 1.20	22s	50s	60sK-80sC	3.80	6-1/2	.48
1.21 to 1.24	22s	50s	60sK-80sC	3.75	6-1/2	.48
1.25 to 1.28	22s	50s	60sK-80sC	3.70	6-1/2	.48
Organization IV - Combed yarns only:						
1.29 to 1.32	50s	80s	100sC	3.65	3-1/2	0.54
1.33 to 1.36	50s	80s	100sC	3.60	3-1/2	.54
1.37 or more	50s	80s	100sC	(as required)	3-1/2	.54

1/ K represents carded yarns and C represents combed yarns. When a yarn number requested is found to be too fine to spin from a particular cotton because of excessive spinning end breakage, the results for such yarns will be reported as "too fine to spin from this cotton." If this number is not finer than the finest spinnable number as listed in the table, however, a coarser number that is within the spinnable limits of the cotton will be substituted.

Table 3.--Spinning test procedures for specified standard organizations

Process	Specified Organization 1/			
	I	II	III	IV
1. PICKER				
Each test lot is processed through a finisher type picker twice to produce the specified weight of lap (ounces per yd.)	11	11	11	11
Type of beater	Kirschner	Kirschner	Kirschner	2-blade
Beater speed (r.p.m.)	1,000	1,000	1,000	1,000
Settings:				
Feed roll to beater (inches)	3/16	3/16	3/16	3/8
Grids to beater, top (inches)	5/16	5/16	5/16	9/16
Grids to beater, bottom (inches)	11/16	11/16	11/16	9/16
2. CARD				
Feed, picker lap (oz. per yd.)	11	11	11	11
Delivered one sliver (grains per yd.)	40	40	40	40
Production rate (pounds per hour)	12-1/2	9-1/2	6-1/2	3-1/2
Doffer speed (r.p.m.)	14	10	7	4
Cylinder speed (r.p.m.)	165	165	165	165
Speed of flats (inches per minute)	2-7/8	2-7/8	2-7/8	2-7/8
Licker-in speed (r.p.m.)	435	435	435	435
Settings:				
Feed plate to licker-in (inches)	0.010	0.010	0.010	0.017
Mote knife to licker-in, top (inches)	.012	.012	.012	.012
Mote knife to licker-in, bottom (inches)	.010	.010	.010	.010
Licker-in screen, front (inches)	.029	.029	.029	.029
Licker-in screen, back (inches)	.017	.017	.017	.017
Licker-in to cylinder (inches)	.007	.007	.007	.007
Flats to cylinder, back, center, and front (inches)	.009	.009	.009	.009
Back plate to cylinder, top (inches)	.029	.029	.029	.029
Back plate to cylinder, bottom (inches)	.034	.034	.034	.034
Front plate to cylinder, top (inches)	.029	.029	.029	.029
Front plate to cylinder, bottom (inches)	.034	.034	.034	.034
Doffer to cylinder (inches)	.007	.007	.007	.007
Cylinder screen, back (inches)	.029	.029	.029	.029
Cylinder screen, center (inches)	.034	.034	.034	.034
Cylinder screen, front (inches)	3/16	3/16	3/16	3/16
Doffer comb to doffer (inches)	.022	.022	.022	.022
3. SLIVER LAPPER (combed only)				
Fed, 20 slivers (wt. per yd. each, grains)	----	40	40	40
Delivered 1 lap (grains per yd.)	----	525	525	525
Speed (yds. per minute)	----	46	46	46
Roll settings (center to center):				
First to second (inches plus fiber length) 2/	----	5/16	5/16	5/16
Second to third (inches plus fiber length) 2/	----	9/16	9/16	9/16
4. RIBBON LAPPER (Combed only)				
Fed, four sliver laps (grains per yd, each)	----	525	525	525
Delivered one lap (grains per yd.)	----	610	610	610
Speed (yards per minute)	----	47	47	47
Roll settings (center to center):				
First to second (inches plus fiber length) 2/	----	4/16	4/16	4/16
Second to third (inches plus fiber length) 2/	----	7/16	7/16	7/16
Third to fourth (inches plus fiber length) 2/	----	10/16	10/16	10/16
5. COMBER (Model D-4)				
Fed, eight ribbon laps (grains per yd., each)	----	610	610	610
Delivered, one sliver (grains per yd.)	----	40	40	40
Production per hour (pounds)	----	13	13	13
Cushion plate to detaching roll setting (inches)	----	.42	.48	.54
Estimated or nominal waste (percent)	----	12	15	18

Continued on page 37.

See footnotes at end of table.

Table 3.--Spinning test procedures for specified standard organizations (Continued)

Process	Specified Organization 1/			
	I	II	III	IV
6. DRAWING FRAME (leather top rolls)				
Carded stocks, first process:				
Fed, 6 card slivers (grains per yd. each)	40	40	40	----
Delivered one sliver (grains per yd.)	42	42	42	----
Carded stocks, second process:				
Fed, 6 slivers (grains per yd. each)	42	42	42	----
Delivered one sliver (grains per yd.)	44	44	44	----
Combed stocks (one process only):				
Fed, 6 comber slivers (grains per yd. each)	----	40	40	40
Delivered, one sliver (grains per yd.)	----	44	44	44
Speed (yards per minute)	36	36	36	36
Roll settings (center to center):				
First to second (inches plus fiber length) 2/	4/16	4/16	4/16	4/16
Second to third (inches plus fiber length) 2/	7/16	7/16	7/16	7/16
Third to fourth (inches plus fiber length) 2/	10/16	10/16	10/16	10/16
7. LONG DRAFT ROVING (8 x 4, 2 apron type)				
Fed, one sliver (grains per yd.) 3/	44	44	44	44
Delivered, 1.50 through 4.50 hanks 4/				
Spindle speed (r.p.m.)	1,250	1,250	1,250	1,250
Roll settings (center to center):				
First to second, standard (inches)	2-1/4	2-1/4	2-1/4	2-1/4
Third to fourth (inches plus fiber length) 2/	1/4	1/4	1/4	1/4
8. REGULAR DRAFT ROVING (6 x 3, for 80s and 100s combed yarns)				
Fed double (hanks each)	----	----	----	3.25
Delivered (hanks)	----	----	----	8.50
Spindle speed (r.p.m.)	----	----	----	1,200
Roll settings (center to center):				
First to second (inches plus fiber length) 2/	----	----	----	2/16
Second to third (inches plus fiber length) 2/	----	----	----	4/16
9. LONG DRAFT SPINNING (two apron type)				
Fed double for 8s (hanks each) 5/	1.50	----	----	----
Fed double for 22s (hanks each)	3.25	3.25	3.25	----
Fed double for 40s, 50s, & 60s (hanks each)	----	4.50	4.50	4.50
Fed double for 80s & 100s (hanks each)	----	----	----	8.50
Spindle speeds for 8s (r.p.m.) 5/	5,500	----	----	----
Spindle speeds for 22s (r.p.m.)	9,500	9,500	9,500	----
Spindle speeds for 44s (r.p.m.)	8,750	8,750	8,750	8,750
Spindle speed for 50s, 60s, 80s, & 100s (r.p.m.)	----	8,500	8,500	8,500
Roll settings (center to center):				
First to second, standard (inches)	2-1/16	2-1/16	2-1/16	2-1/16
Second to third, standard (inches)	1-3/4	1-3/4	1-3/4	1-3/4

1/ Based on Fibrograph upper half mean length as shown in table 2.
2/ Fiber lengths shown are in terms of "pulls" made on card sliver which are approximate equivalents of Fibrograph upper half mean lengths used in laboratory procedure.
3/ Inter-draft roving (8 x 4, 4 roll type) substituted for 8s carded yarns.
4/ See item 9, Long draft spinning, for hanks delivered.
5/ Spun on wide guage spinning frame.

6. Spinning twist multiplier, yarn skein strength of each yarn number, and average carded and/or combed yarn break factors.
7. Yarn appearance grade of each yarn number and average carded and/or combed yarn appearance indexes.
8. Comments summarizing any unusual processing observations that are not covered by the data reported.

In evaluating the spinning test results, too much significance should not be attached to small differences shown for individual tests. In practical application, it should be remembered that a small difference in a single measurable property may be overshadowed by other properties. Conclusions, therefore, should be made only after consideration of all test results.

The results of tests conducted on a large number of lots of cotton provide bases as described in subsequent paragraphs for the evaluation of specific test results.

Manufacturing waste.--The manufacturing waste for a sample of cotton is important because excessive waste increases the cost of processing. The percentage of waste extracted by the picking and carding processes in performing a spinning test provides a measure of manufacturing waste. There is an average relationship between this waste and grade which is an indication of the waste content of a cotton. As the quantity of waste extracted by the picker and card for a particular grade is affected by the characteristics of the fiber, the nature of the extraneous material, and whether the grade designation was lowered because of poor color, there are variations from the average relationship in the results for individual samples. Also, the rate at which the samples are carded affects the picker and card waste values because the more thorough carding action obtained when the carding rate is decreased extracts a larger quantity of waste. The longer staple cottons are generally carded at a lower rate than the shorter cottons in order to obtain acceptable yarn quality. Past experience has shown the average relationship between grade and manufacturing waste, as based on medium staple upland cottons when carded at 9-1/2 pounds per hour, to be approximately as follows.

Grade	Average picker and card waste Percent
Good Middling.........................	6.3
Strict Middling.......................	7.2
Middling..............................	8.1
Strict Low Middling...................	9.3
Low Middling..........................	12.5
Strict Good Ordinary..................	15.6
Good Ordinary.........................	18.3

When combed yarn tests are requested, the percentage of waste removed by the comber is furnished in addition to the picker and card waste. The shorter staple cottons are processed through the comber with a closer setting than that for the longer staple cottons because smaller comber waste percentages are usually extracted from this cotton in commercial practice.

Waste results obtained in the laboratories of the Cotton Division for cottons which have been tested periodically over a period of years provide an indication of the reproducibility of results for this phase of the spinning tests, as follows:

Item	Standard error
Carded yarn tests (5 cottons in 2 laboratories):	
Picker and card waste (percent)...............	± 0.8

Nep content.--A desirable feature of any cotton is its relative freedom from neps, because they may be a source of trouble in manufacturing yarns and fabrics. The occurence of neps in appreciable numbers detracts from the appearance of those products. This is expecially true when they are to be dyed or printed because neps absorb dyes differently and appear as spots on the material. A determination of the number of neps per 100 square inches of card web during the processing of each spinning test lot provides a measure of the nep content. This determination is based on 10 specimens of card web totaling 360 square inches and is evaluated independently by two technologists.

When the nep count is high, the cotton is likely to produce rough and neppy yarns. The longer staple cottons are carded at a lower rate of production than the shorter staple cottons primarily because the longer staple cottons are more susceptible to the formation of neps. The following adjective descriptions based on standard weight card sliver of 40 grains per yard and the standard carding rate for the particular cotton will serve to classify cottons from the standpoint of neppiness:

Number of neps per 100 square inches of card web	
15 and below....................	Low
16 to 30........................	Average
31 to 45........................	High
46 and above....................	Very high

The nep results obtained in the laboratories of the Cotton Division for cottons which have been tested periodically over a period of years provide an indication of the reproducibility of results for this phase of the spinning tests. The following value is based on 10 specimens per test for 3 medium staple upland cottons when carded at 9-1/2 pounds per hour in 2 laboratories:

Item	Standard error
Neps per 100 sq. in. of card web	± 2.9

Yarn strength and yarn break factor.--Probably the most important reliable single index of spinning quality is the yarn strength. An automatic reel, having a circumference of 1-1/2 yards, is used to form skeins for the test (fig. 31). Each of these skeins is composed of 120 yards of yarn obtained from a bobbin by 80 revoluations of the reel. After the skeins have been exposed for 4 hours or more to standard atmospheric conditions, they are broken on a pendulum-type tester (fig. 32). A minimum of 25 skeins is tested to obtain the skein strength value reported for each yarn number in the test. In the yarn-testing laboratory, the actual breaking strength of each skein is recorded, along with the actual yarn number, which is obtained by weighing the broken skein on a yarn-numbering quadrant. These actual strength and yarn number data are used to calculate the breaking strength reported for each yarn number spun.

Yarns of at least average strengths are desirable, as they not only increase the range of usefulness of a given cotton but are also an indication of good spinning and weaving performance. In general, the strength values shown are higher than those obtained in commercial mills. This is explained by the following facts: Twist multipliers used in spinning yarns at the laboratories are designed to give the highest yarn strengths obtainable from each individual cotton tested; that it is necessary to keep the laboratory processing machinery in excellent condition at all times in order to provide test results that are strictly comparable; and laboratory results are to a large extent based on yarns manufactured from pure varieties of cotton. In other words, the degree of precision which is necessary for laboratory testing may not be economically feasible in a commercial textile mill.

There is an average relationship between yarn strength and staple length, but this average varies, attributable to the characteristics of the fiber in individual samples. The break factor as reported in connection with spinning tests provides a means of comparing the average yarn strength obtained from different cottons directly. Also, the relative yarn strength of a cotton as compared with the average or standard yarn strength for cottons of the same staple length may be obtained by comparing the break factor reported with the comparable average or standard value as listed in table 4.

Yarn strength results obtained in the laboratories of the Cotton Division for cottons tested periodically over a number of years provide an indication of the reproducibility of results for this phase of the spinning tests, as follows:

Item	Standard error
Carded yarn break factor	± 43
Combed yarn break factor	± 47

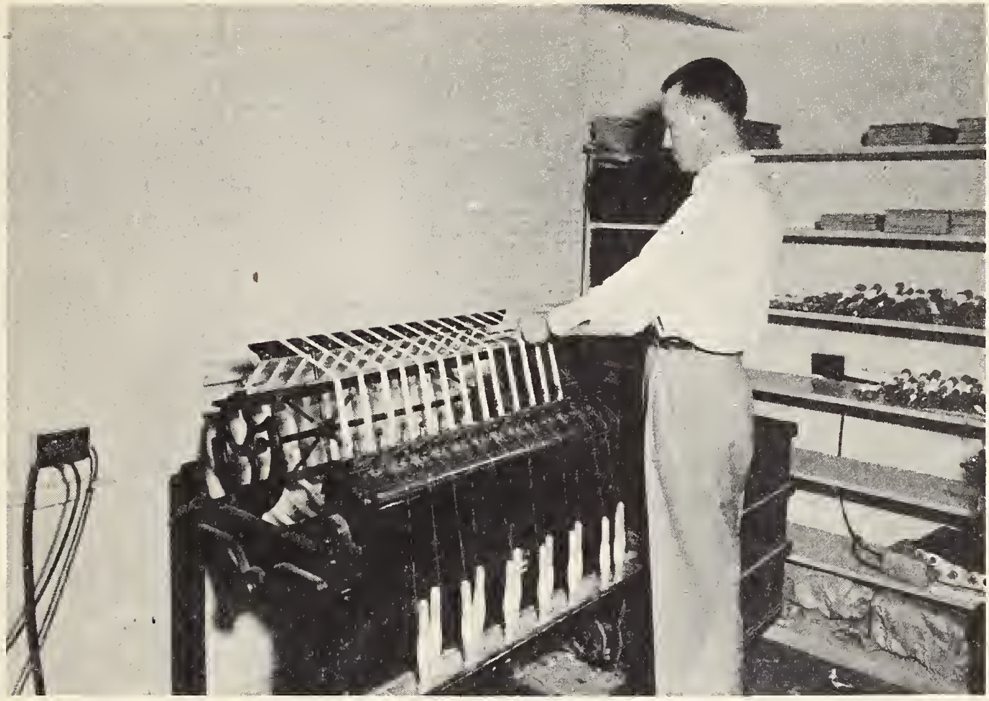


Figure 31.--Technician processing a test sample of yarn into skeins for strength tests.

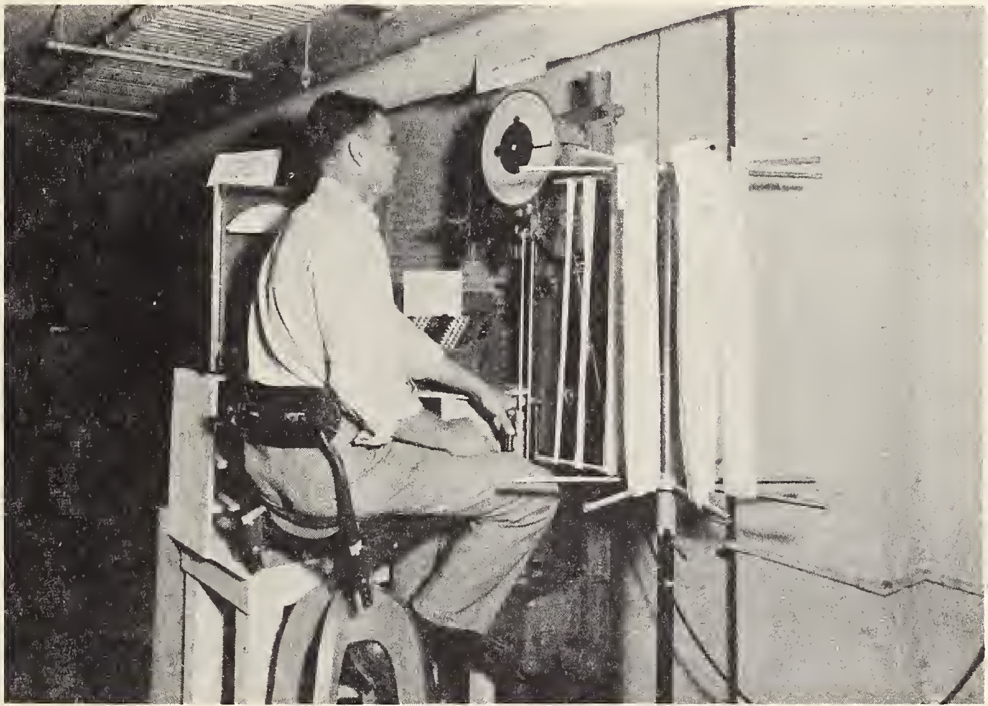


Figure 32.--Technician performing skein strength tests on test samples of yarn.

Table 4.--Average or standard break factors for skein strength of specified yarn number combinations, and classers' staple lengths

Type of cotton and classers' staple length	Average break factors for-- 1/			
	Carded yarn numbers of--		Combed yarn numbers of--	
(Inches)	8s and 22s	22s and 50s	22s and 50s	50s and 80s
	Lb. x No.	Lb. x No.	Lb. x No.	Lb. x No.
American upland:				
3/4	1575			
25/32	1675			
13/16	1779			
27/32	1886			
7/8	1998	1634		
29/32	2114	1749		
15/16	2233	1869		
31/32	2357	1992		
1	2484	2120	2332	
1-1/32	2616	2251	2477	
1-1/16	2751	2387	2626	
1-3/32	2891	2526	2779	
1-1/8		2670	2937	
1-5/32		2817	3099	
1-3/16		2968	3265	
1-7/32		3123	3436	
1-1/4		3282	3611	
1-9/32		3446	3791	
1-5/16		3613	3974	
1-11/32		3784	4163	
American Egyptian:				
1-3/8				2834
1-13/32				2986
1-7/16				3142
1-15/32				3302
1-1/2				3465
1-17/32				3631
1-9/16				3801

1/ Break factor values listed above are the average of the skein strengths in pounds times the yarn numbers for the 2 yarn numbers specified.

Yarn appearance and yarn appearance index.--The appearance of the yarn in many types of woven or knitted materials is a very important quality factor. The appearance of each yarn number spun in connection with a spinning test is expressed in terms of yarn appearance grades. Photographic standards for these grades were developed by the laboratories of the Cotton Division and have been adopted by the American Society for Testing Materials (fig. 33). Samples of yarn are wound on black boards (fig. 34) for comparison with the standards (fig. 35). The yarn appearance index provides a means of averaging the appearance grade of two or more yarn numbers and for comparing yarn appearance values obtained in the testing of a specific sample with those of the general average of cotton. A yarn appearance index greater than 100 indicates higher than average yarn appearance, whereas, a yarn appearance index smaller than 100 indicates lower than average yarn appearance. For example, a given sample might have yarn appearance grades of B for 22s, and C+ for 50s. In that case, the yarn appearance index reported, which is based on all yarn numbers spun, would be 105, indicating that the yarn appearance grades obtained were above average. The following descriptive designations will aid in evaluating the results reported:

Yarn appearance

Grade	Designation	Index
A	Excellent	130
B+..............	Very good	120
B	Good	110
C+..............	Average	100
C	Fair	90
D+..............	Poor	80
D	Very poor	70
BG (Below grade)	Very poor	60

Yarn appearance results obtained in the laboratories of the Cotton Division for cottons which have been tested periodically over a number of years provide an indication of the reproducibility of results for this phase of the spinning tests as follows:

Item	Standard error
Average carded yarn appearance (index)........	± 3.8
Average combed yarn appearance (index)........	± 4.5

Spinning and testing additional yarn (16).--In the event the two yarn numbers provided in connection with spinning tests are not adequate for the specific purposes of an applicant, provision is made for the spinning of any extra numbers desired so long as they are within the spinnable range of the cotton. Yarn skein strength results are reported for both single yarns (item 16a) and 2-or-3-ply yarns (item 16b). Yarn appearance grades, however, are reported for only the single yarns.

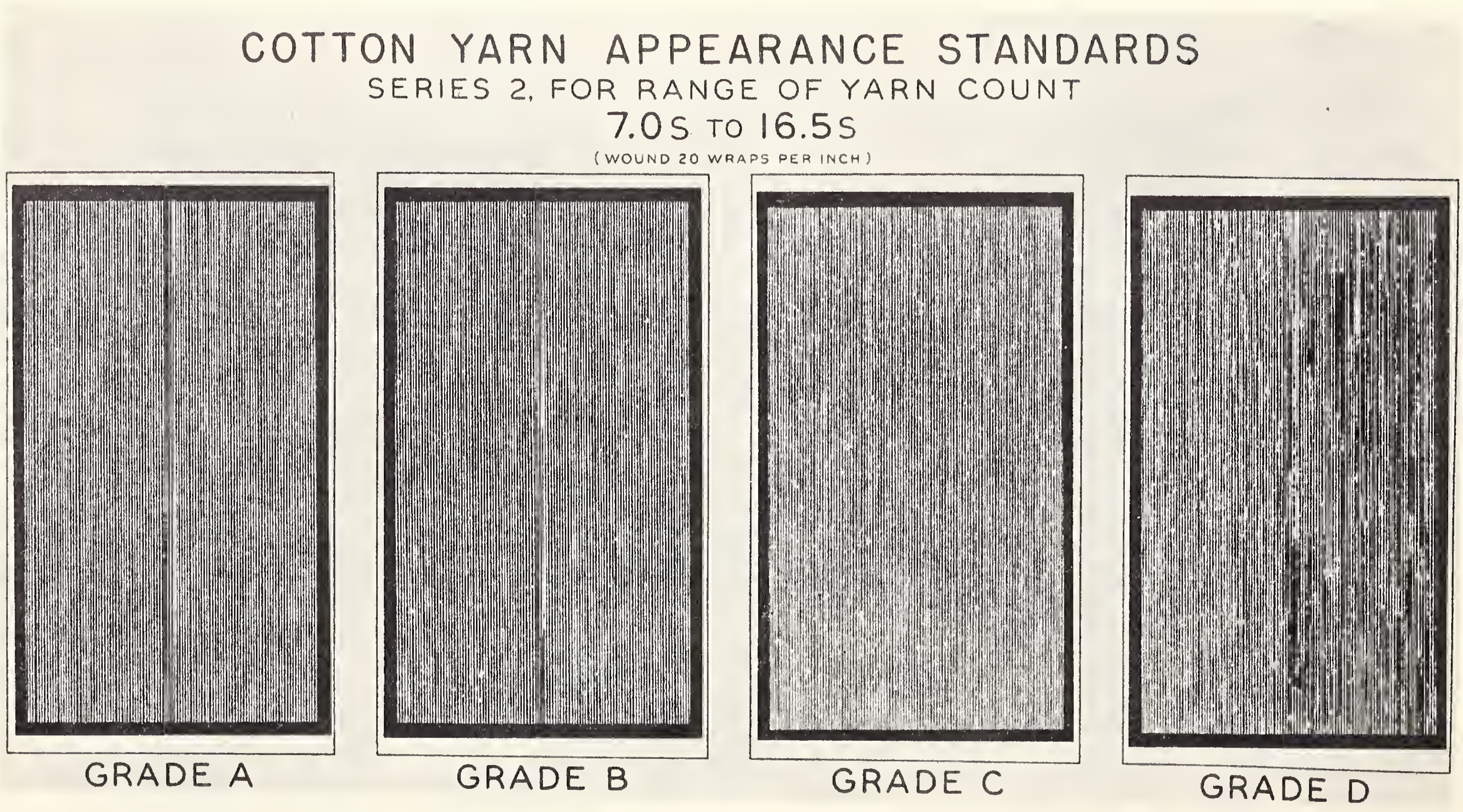

COTTON YARN APPEARANCE STANDARDS
SERIES 2, FOR RANGE OF YARN COUNT
7.0S TO 16.5S
(WOUND 20 WRAPS PER INCH)
GRADE A
GRADE B
GRADE C
GRADE D

Figure 33.--One of the series of 5 standards used to grade yarn for appearance (about 1/3 actual size).

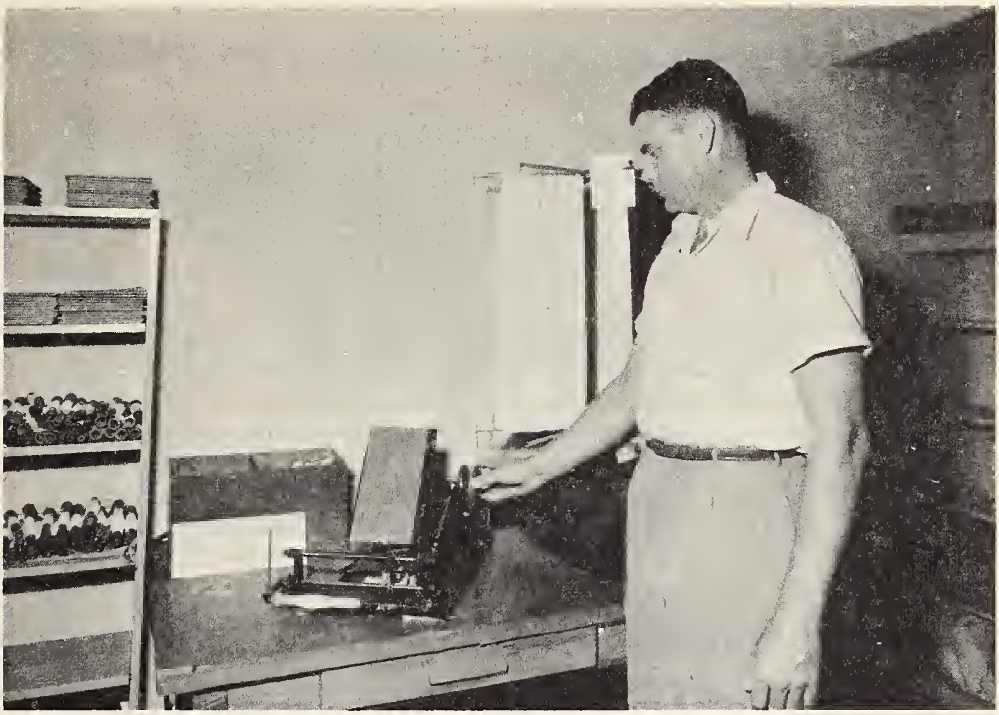


Figure 34.--Technician winding a test sample of yarn for appearance grading.

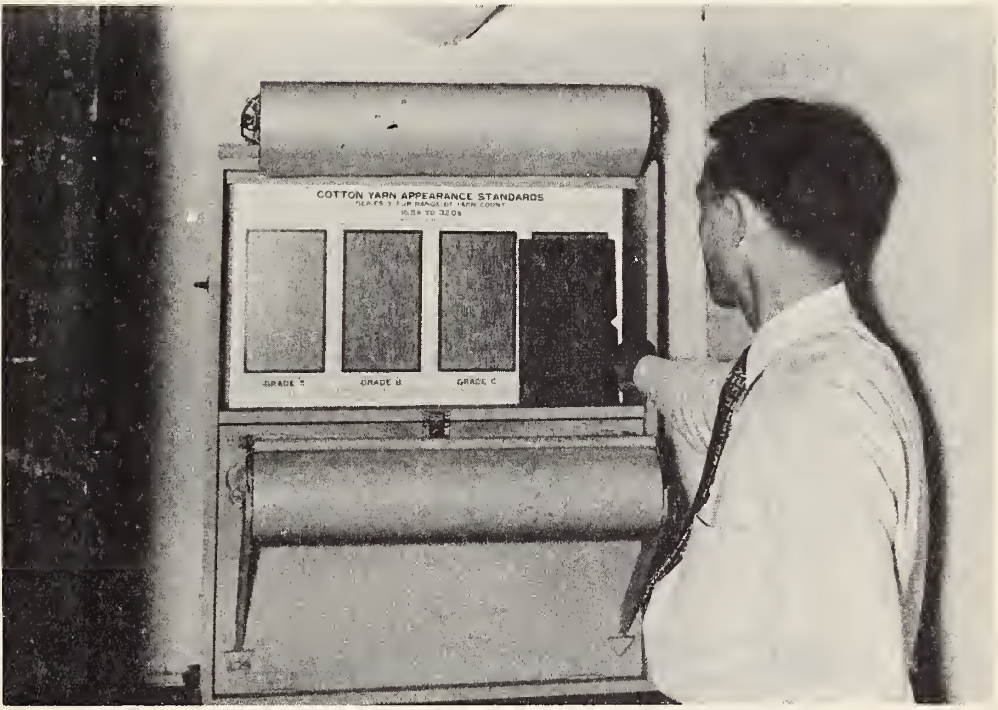


Figure 35.--Technician grading a test sample of yarn for appearance by comparing it with the standards.

Provision has also been made in connection with spinning tests to furnish small quantities of yarn to the applicant for further study (item 16.1). When this item is requested, the sample of cotton submitted for the spinning test must be larger in proportion to the quantity of yarn desired.

Spinning twist test (17).--For item (17) one yarn number is spun with each of 6 twist multipliers from a sample of raw cotton, picker lap, sliver, or roving as a basis for determining the twist multiplier that will result in yarns having the greatest skein strength. The results obtained from the test also show the extent to which yarn strength falls off when somewhat more or less than the optimum twist is used. The test is made on any yarn that is within the spinnable range of the cotton. The results reported are based on 25 skein breaks for each of the 6 twists spun. Spinning twist tests on additional yarn numbers or using additional twists from the same material can be obtained by requesting item (17.1).

Fabric weaving and testing (19).--Fabric for this item may be woven either in connection with spinning tests item (19a) or from yarns furnished by the applicant (item 19b). The test item includes warping and slashing of the yarn, weaving of a fabric 11-3/4 inches wide, testing of the fabric and spinning of the yarn for weaving when performed in connection with spinning tests. Any standard fabric construction which the laboratories are equipped to produce may be specified by the applicant, otherwise, the fabric will be woven in accordance with the following nominal specifications:

Construction.........	68 x 72
Warp.................	21s
Filling..............	23.6s
Weight...............	4.9 oz. per yard

Results reported for this test show the actual and nominal weight of the fabric, warp and filling counts and the results of fabric strength warpwise and fillingwise in accordance with the methods outlined for item (20).

Waste and nep content (21).--This item affords a means for comparing the relative wastiness and neppiness of 5-pound samples of cotton in the event it is not desired to make complete spinning tests. The cotton is processed through the pickers and card for cleaning and waste removal in the same manner as for spinning tests. The percentage of picker and card waste and the average number of neps per 100 square inches of card web are reported for this item. These tests are discussed in preceding paragraphs under "Manufacturing waste" and "Nep content."

Other Tests

Yarn skein strength, number, and appearance grade (18 and 18.3).--These items afford a means for a cotton manufacturer to compare yarns processed in his own mill from cotton submitted for laboratory spinning tests with yarns processed at the laboratories of the Cotton Division. Item (18) includes the reeling, conditioning, breaking, and sizing of 25 skeins from the bobbins submitted as representative of a given lot of yarn. The average skein strength and average yarn number are reported. Item (18.3) includes the preparation and grading of one yarn appearance board. The average yarn appearance grade is reported.

Single strand yarn strength test (18.1 and 18.2).--The Moscrop tester is a single strand strength-testing machine that accommodates 6 bobbins at one time. It automatically threads and breaks the yarn and records the strength automatically on a special recording chart from a minimum of 36 successive 10-inch lengths from each bobbin. The average breaking strength and the actual number of the yarn obtained by reeling and sizing one skein from each of the 6 bobbins are reported when item (18.1) is requested. Where detailed analyses of the individual breaks are desired, copies of the chart on which the breaks are automatically recorded will be furnished when item (18.1a) is requested along with the Moscrop test.

The pendulum testing machine for single strand tests is similar to the one used for skein tests. It has a smaller capacity, however, and is equipped with single strand jaws. A total of 25 breaks is made on each lot of yarn tested, and the average strength is reported for item (18.2).

Strength of fabric test, grab method (20).--This item affords a means for a cotton manufacturer to compare the fabrics processed in his own mill with fabrics processed in the laboratories of the Cotton Division. The test includes the preparation of the samples and strength tests on five fabric specimens, measuring 4 by 6 inches each, for both warp and filling. The specimens are taken from fabric, furnished by the applicant, which should measure at least 1-yard square and should contain one selvage. The report includes the average strength for both warp and filling.

Analysis and sizing content of fabric (20.1 and 20.2).--These items afford a means for the applicant to obtain additional information on fabric woven in either the laboratory or in his own mill. Item (20.1) includes the number of warp and filling threads per inch and weight per yard of fabric, whereas, item (20.2) includes the sizing content of the fabric.

Furnishing identified cotton samples (26).--This item affords a means for the applicant to obtain identified samples taken at any of the stages of processing or testing for cottons submitted for fiber or spinning tests.

Furnishing extra copies of test data (24, 27, and 27.1).--Copies of the test data work sheets which contain detailed data and calculations may be obtained by requesting item (24). Copies of the test report in addition to the two copies which are routinely furnished may be obtained by requesting item (27). A certified relisting of test results for selected samples from previous tests may also be obtained by requesting item (27.1).

VARIABILITY WITHIN BALES OF COTTON

In view of the high degree of variability for all measurable properties of cotton, the applicant for service tests should be fully aware of the limitations of the various tests that are imposed by such variability in the material tested. Otherwise, too much significance may be attached to small differences in the test results, and erroneous conclusions may be drawn. It is for this reason that data pertaining to the variability of cotton within individual bales are included in this report.

Variability of cotton within a single bale actually is much greater than is usually appreciated. Fibers from bolls produced on different parts of a single cotton plant develop at different times under different environmental conditions. As a result, they vary considerably in physical properties. Even on the same seed the fibers vary greatly, depending on their position on the seed. Frequently the cotton in a bale is harvested at different times and under different conditions. The cotton may come from different parts of the field and from different varieties. Under present procedures of ginning, a bale often contains some cotton from the bale ginned previous to it. There are other factors contributing to variability in cotton.

An indication of the extent of variability of the physical properties of cotton fibers within a single bale may be obtained from the data presented in table 5. Bales reported in this table were sampled in 10 positions throughout each bale, and the test results were based on tests made on the individual samples. It should be understood, however, that these data represent about the minimum of variability for commercial bales of cotton because each bale reported in table 5 consisted of cotton of a pure variety that was so ginned and selected as to provide maximum practical uniformity in quality within the bale in each instance. Most bales of cotton will show greater variability than that indicated here in table 5.

RELATIONSHIP OF TEST DATA TO PUBLISHED REPORTS

Users of the testing service may, upon request, have their names placed on a mailing list to receive publications, issued from time to time, dealing with various research studies and reporting test results for the improved varieties of cotton grown and tested each year. The data reported in these publications provide a basis for evaluating test results and for comparing the specific cottons submitted for test with the various improved varieties. In making such comparisons, however, it should be kept in mind that the precision indicated in this report will, no doubt, be further improved. The test methods are being studied continually for the purpose of improving the precision of the tests and reducing the time required for performing them.

Table 5.--Extent of variability in specified fiber properties within individual bales of pure variety cotton, selected to assure maximum practical uniformity in quality, in comparison with standard errors of fiber tests

Bale No.	Range of fiber measurements within bales 1/				
	Length - Fibrograph		Strength (Pressley)	Fineness (Micronaire)	Maturity (Random Sample)
	Upper half mean	Uniformity			
	Inches	Index	1,000 lb. per sq. in.	ug/in.	Percent
1	0.03	3	9	0.2	7
2	.04	2	6	.2	7
3	.02	1	6	.2	8
4	.02	5	7	.2	10
5	.04	4	4	.1	8
6	.03	5	5	.1	12
7	.06	2	4	.3	13
8	.02	3	4	.2	8
9	.03	3	5	.2	11
10	.04	2	9	.3	13
11	.07	3	5	.2	6
Average	.036	3.0	5.0	0.20	9.4
Standard error for test 2/	± 0.008	± 1.1	± .9	± .05	± 1.0

1/ Data with respect to variability within bales are based on 10 complete tests made on 10 samples taken from different positions throughout each bale.

2/ Data with respect to precision of tests are based on special studies.

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